Physical Parameters of Sockeye Salmon *(Oncorhynchus nerka)* Rearing Lakes Under Study by the Enhancement Assessment Unit

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PHYSICAL PARAMETERS OF SOCKEYE SALMON (*Oncorhynchus nerka*) REARING LAKES UNDER STUDY BY THE ENHANCEMENT ASSESSMENT UNIT

May 1986

by

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ABSTRACT

Rutherford, D. T., K. D. Hyatt, J. E. Radziul, and G. J. Steer. 1986. Physical parameters of sockeye salmon (Oncorhynchus nerka) rearing lakes under study by the Enhancement Assessment Unit. Can. MS Rep. Fish. Aquat. Sci. 1878: 114 p.

Standardized physical parameter data and a compendium of maps of sockeye salmon (Oncorhynchus nerka) rearing lakes under study by the Enhancement Assessment Unit (EAU) are presented. These data may be used by the Lake Enrichment Program (LEP) and EAU in both the application and assessment of lake fertilization. Data presented include lake and watershed areas, lake elevation, lake coordinates, shoreline development, shoreline length, mean annual precipitation, lake volume, maximum and mean depths and length of transects and lake areas at depth used for hydroacoustic assessment of fish abundance. Maps illustrate watershed boundaries, topography, lake bathymetry and hydroacoustic transect locations.

RESUME

Rutherford, D. T., K. D. Hyatt, J. E. Radziul, and G. J. Steer. 1986. Physical parameters of sockeye salmon (Oncorhynchus nerka) rearing lakes under study by the Enhancement Assessment Unit. Can. MS Rep. Fish. Aquat. Sci. 1878: 114 p.

Nous présentons les données standardisées sur les paramètres physiques et un condensé de cartes des lacs d'élevage du saumon nerka (Oncorhynchus nerka) présentement à l'étude par l'Unité d'évaluation de la mise en valeur (EAU pour Enhancement Assessment Unit). Ces données pourront être utilisées par le Programme d'enrichissement des lacs (LEP pour Lake Enrichment Program) et par EAU tant pour l'application que pour l'évaluation de la fertilisation des lacs. Parmi les données présentées on note: superficie des lacs et des bassins hydrographiques, altitude des lacs, coordonnées des lacs, développement de la ligne de rivage, longueur de la ligne de rivage, précipitation moyenne annuelle, volume des lacs, profondeurs maxima et moyennes, longueur des coupes et superficie du lac à la profondeur utilisée pour l'évaluation hydroacoustique de l'abondance des poissons. Les cartes montrent les frontières des bassins hydrographiques, la topographie, la bathymétrie des lacs et l'emplacement des coupes hydroacoustiques.

INTRODUCTION

In recent years, the addition of inorganic nutrients to ultraoligotrophic, sockeye rearing lakes along the coast of British Columbia has emerged as a promising technique for increasing the production of sockeye salmon (Oncorhynchus nerka) (Stockner and Hyatt 1984; Hyatt and Stockner 1985). The use of lake fertilization by the Salmonid Enhancement Program (SEP) has increased from application to one lake in 1976 to a total of fifteen lakes in 1983 (Stephens and Stockner 1983). The Fisheries Research Branch serves as the source of scientific and technical expertise for the application and evaluation of this technique with funding provided by SEP.

The Lake Enrichment Program (LEP) is primarily responsible for fertilizer application and the assessment of water chemistry and plankton responses and the Enhancement Assessment Unit (EAU) is primarily responsible for the evaluation of fish community responses, particularly those of juvenile and adult sockeye salmon. These assessments involve research activities associated with surveys of up to twenty-five remote lakes dispersed along the entire length of the B.C. coast (Fig. 1).

The purpose of this report is to bring together relevant physical and environmental data on these lakes and their corresponding maps into a reference document containing standard parameters that can be used by both the EAU and LEP. Comparable parameters used in previous reports have differed apparently due to rounding off but other differences are too large to be explained by this alone (Table 1). The physical and environmental data include lake coordinates, elevation, lake and watershed areas, maximum and mean depths, shoreline development, shoreline length, mean annual precipitation, volume and lengths of transects and lake areas at depth used for hydroacoustic assessment of fish abundance. The compendium of maps contains four maps for each lake: 1) watershed boundary, 2) topography, 3) bathymetry and 4) transect locations. The last map shows the transect lines used by EAU on which hydroacoustic and other biological sampling activities (Hyatt et al. 1984) are carried out.

METHODS

Lake area (ha), watershed areas (ha), elevation (m) and lake coordinates (Table 1) are taken from 1:50,000 or 1:250,000 topographic maps from the National Topographic Series (Province of British Columbia, Surveys and Mapping Branch). Lake and watershed areas were measured three times with a Model 620022 Keuffel and Esser compensating polar planimeter and the mean was used for the area. Location coordinates intersect at the centre of the lake basin for single basin lakes and at the boundary between basins for two basin lakes.

Shoreline development (Table 2) is the ratio of the length of the shoreline (L) to the length of the circumference of a circle with area equal to that of the lake (Wetzel 1975):

$$DL = \frac{L}{2*(\pi A_o *10{,}000)^{1/2}}$$

where
DL = Shoreline development
L = Length of shoreline (m)
A_o = Surface area of lake (ha)

Shoreline length (L) was measured three times on a 1:50,000 topographic map using a Model Digi-Pad 5 digitizing table (GTCO Corporation) and the mean was used in the shoreline development calculation.

Precipitation data (Environment Canada, Atmospheric Environment Service) are from the weather station in closest proximity to a given study lake. Only years with complete rainfall data were used in calculating mean annual precipitation (Tables 2 and 3).

Maximum depth (Table 2) and lake bathymetry were determined from echo-soundings taken by Department of Fisheries and Oceans personnel using Simrad EYM or Furuno FM22 echo-sounders in accordance with procedures in Hyatt et al. (1984). The number of transect lines used to determine lake bathymetry is based on lake size and basin complexity and consequently varies substantially between lakes (Table 4). Echosounding along transects used for the hydroacoustic assessment of fish abundance were supplemented with soundings initiated specifically for the purpose of determining lake bathymetry.

Bathymetric maps were prepared as follows. Lake outlines from 1:50,000 topographic maps were enlarged using a projection enlarger and echosounding transects with start and end points were drawn. For each transect, the surface distance on the echogram was measured. Vertical lines were then drawn on the echogram from the bottom contour up to the surface at 5 m depth intervals. Depth contours on the echogram were scaled and transferred to the corresponding transect on the enlarged map.

The distance to each depth contour along the transect on the map was calculated by:

$$dm = de * tdm / tde$$

where
dm = Distance to depth contour on map
tde = Echogram surface distance
tdm = Transect surface distance on map
de = Distance to depth interval on echogram

Bathymetric contours were fitted by eye starting with the deepest contour.

Stratum area (Table 5) was taken at the mid-point of the depth interval and was calculated by averaging the areas corresponding to the stratum's upper and lower contours.

Actual transect lengths at depth (Table 5) were calculated from the echograms and 1:50,000 topographic maps. The actual length of the transect at the surface was measured on the 1:50,000 topographic map. Transect length at depth was measured on the echogram at the midpoint of the depth interval and converted to actual length using the transect surface length on the echogram and the actual surface length from the map.

$$tld = tlde * tls / tlse$$

where

tld = Actual transect length at depth (m)
tls = Actual transect surface distance from topographic map (m)
tlse = Echogram surface distance (mm)
tlde = Transect distance at depth on echogram (mm)

Lake volume (Table 2) was calculated by summing the stratum volumes and the volume of the lake below the deepest measured stratum for that lake. Stratum volume (V_i) was calculated by:

$$V_i = \frac{h}{3} (A_1 + A_2 + (A_1 * A_2)^{1/2}) * 10{,}000$$

(Wetzel 1975)

where

h = Vertical distance between stratum points (m)
A_1 = Area of upper stratum (ha)
A_2 = Area of lower stratum (ha)

The volume of the lake below the deepest measured stratum was calculated by letting the area of the lower stratum equal zero, the area of the upper stratum equal that of the deepest measured stratum, and the vertical distance equal the difference between maximum depth and the vertical depth to the midpoint of the deepest measured stratum.

Mean depth (Table 2) was calculated by dividing lake volume by lake surface area.

$$Z = V / (A_o * 10{,}000)$$

where

Z = Mean depth (m)
V = Lake volume (m^3)
A_o = Lake surface area (ha)

ACKNOWLEDGMENTS

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Table 1. Lake areas used in previous reports.

Lake	Reported area (ha)			
	Duval and Murray (1976)	Hyatt and Stockner (1985)	Stockner and Shortreed (1985)	This report
Awun		465	490	479
Bonilla		207	230	216
Cheewhat				152
Curtis		247	300	266
Devon		167	180	174
Eden		556	590	590
Great Central	4540	5085	5100	5085
Henderson	1700	1545	1500	1545
Hobiton	360	350	360	350
Ian	1720	1809	2000	1903
Jansen				61
Kennedy-Main	4360			4795
Kennedy-Clayoquot	1680	1480		1680
Long	1600	1025	2100	2100
Lowe		358	370	383
Mercer				104
Muchalat	554			642
Muriel				145
Nimpkish	3600	3628	3700	3653
Port John				91
Sproat			4100	3775
Woss			1300	1366
Yakoun			810	818

Table 2. Physical and environmental parameters of EAU study lakes.

Lake	Lake area (ha)	Maximum depth (m)	Mean depth (m)	Elevation (m)	Shoreline development	Mean annual precipitation (mm)	Watershed area (ha)	Coordinates		Shoreline length (m)	Volume ($m^3.10^6$)
								Latitude (North)	Longitude (West)		
Awun	479	88	46	16	2.12	1344	7207	53°36'	132°35'	16479	221
Bonilla	216	80	33	10	2.76	2516	2865	53°31'	130°15'	14417	72
Cheewhat	152	21	9	10	1.39	2509	890	48°41'	125°45'	6113	13
Curtis	266	90	35	10	2.58	2516	6192	53°30'	129°50'	14962	93
Devon	174	76	30	10	2.32	2516	1740	53°27'	129°45'	10881	51
Eden	590	110	42	21	2.00	1344	7585	53°51'	132°43'	17234	249
Great Central	5085	250[b]	124	82	3.25	1843	44840	49°22'	125°15'	82254	6293
Henderson	1545	250[a]	97	1	2.68	6489	14968	49°05'	125°02'	37437	1500
Hobiton	350	95	38	5	2.30	2509	4055	48°45'	124°49'	15269	132
Ian	1903	165	44	35	3.24	1344	25796	53°45'	132°35'	50203	830
Jansen	61	49	30	3	1.63	2627	412	50°06'	127°17'	4542	18
Kennedy	6475	145	38	4	4.49	3114	53821	49°05'	125°33'	111869	1890
Kennedy(Clayoquot)	1680	130[a]	49	4	3.05	3114	13885	49°08'	125°35'	41752	726
Kennedy(Main)	4795	145	34	4	3.36	3114	39936	49°04'	125°30'	70117	1162
Long	2100	170[a]	80	15	3.59	1780	40800	51°15'	127°10'	58490	1672
Lowe	383	54	12	7	2.33	2516	23312	53°34'	129°33'	16218	48
Mercer	104	32	16	8	2.01	1344	3800	53°34'	132°53'	7276	17
Muchalat	642	63	38	199	1.77	2627	23000	49°41'	126°06'	15962	245
Muriel	145	45	21	11	2.47	3114	950	49°08'	125°36'	10562	30
Nimpkish	3653	320	122	20	2.53	1528	179000	50°25'	125°40'	54282	4467
Port John	91	49	24	40	1.83	4019	760	52°07'	127°49'	6217	21
Sproat	3775	195[c]	74	28	4.16	1843	35541	49°17'	124°55'	90804	2815
Woss	1366	155	65	150	2.90	1528	15700	50°08'	126°38'	38105	894
Yakoun	818	95	34	107	1.98	1344	8352	53°19'	132°17'	20154	279

[a] Duval and Murray (1976)

[b] Barraclough and Robinson (1972)

[c] Facchin and King (1981)

Table 3. Weather stations corresponding to EAU study lakes.

Lake	Corresponding weather station	Number of years averaged	Years
Nimpkish Woss	Alert Bay	3	1980-1982
Cheewhat Hobiton	Carnation Creek	7	1976-1982
Jansen Muchalat	Gold River	7	1976-1982
Henderson	Henderson Hatchery	14	1922-1936
PortJohn	Ocean Falls	8	1975-1982
Great Central Sproat	Port Alberni (airport)	7	1976-1982
Long	Port Hardy	7	1976-1982
Bonilla Curtis Devon Lowe	Prince Rupert (airport)	5	1978-1982
Awun Eden Ian Mercer Yakoun	Sandspit	3	1980-1982
Kennedy Muriel	Tofino	7	1976-1982

Table 4. Number of transects used to determine lake bathymetry.

Lake	Number of transects used
Awun	12
Bonilla	29
Cheewhat	10
Curtis	32
Devon	21
Eden	14
Great Central	-[a]
Henderson	7[b]
Hobiton	11
Ian	48
Jansen	5
Kennedy	14[b]
Long	14[c]
Lowe	20
Mercer	12
Muchalat	5
Muriel	10
Nimpkish	-[d]
Port John	5
Sproat	12[c]
Woss	-[d]
Yakoun	12

[a] Map from Barraclough and Robinson (1972).
[b] LEP soundings for depths to 100 m. Duval and Murray (1976) bathymetry for depths from 100 m to lake bottom.
[c] LEP soundings for depths to 100 m only.
[d] Map from Dept. of Fisheries (1958).

Table 5. Transect lengths and area at depth for EAU study lakes.

Awun Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)
Surface	479	660	950	650	305
0 - 5	465	648	928	650	295
5 -10	440	628	917	635	284
10-15	420	592	893	616	266
15-20	400	556	870	594	249
20-30	370	496	831	566	221
30-40	323	433	779	512	156
40-50	274	336	675	464	
50-60	211	240	575	429	
60-70	136				

Bonilla Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)
Surface	216	275	675	690	230
0 - 5	207	273	668	672	225
5 -10	186	252	649	648	206
10-15	167	233	643	613	183
15-20	149	215	564	590	154
20-30	127	190	547	551	86
30-40	102	164	456	484	
40-50	78	153	364	403	

Table 5 (cont'd)

Cheewhat Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)
Surface	152	750	850	850	800	500	1750
0 - 5	140	721	843	811	743	478	1391
5 -10	86	485	455	630	614	372	1114
10-15	33		301	464	517	239	368
15-20	14			315	348		150

Table 5 (cont'd)

Curtis Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)
Surface	266	690	1020	650	710
0 - 5	247	679	1012	646	698
5 -10	216	656	1004	631	564
10-15	198	621	965	617	504
15-20	186	586	960	603	455
20-30	164	556	743	577	231
30-40	129	452	645	337	134
40-50	93	389	588	123	
50-60	63	305	510		
60-70	40	182	421		

Table 5 (cont'd)

Devon Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)
Surface	174	410	655	500	510
0 - 5	167	390	639	496	507
5 -10	152	382	616	482	496
10-15	141	369	597	467	483
15-20	131	356	562	451	458
20-30	112	334	466	424	388
30-40	68	306	108	272	277
40-50	26	274		106	104
50-60	10				
60-70	4				

Eden Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)
Surface	590	825	705	1320	865
0 - 5	556	775	685	1279	763
5 -10	507	714	669	1050	619
10-15	481	699	623	960	478
15-20	454	641	590	922	386
20-30	397	578	553	790	267
30-40	307	512	513	722	
40-50	239	429	478	630	
50-60	203				
60-70	170				

Table 5 (cont'd)

Great Central Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)
Surface	5085	1260	2160	1560	1370	1780	760
0 - 5	5085	1260	2150	1560	1370	1780	760
5 -10	5054	1250	2140	1554	1365	1770	760
10-15	5022	1240	2140	1548	1360	1770	750
15-20	4959	1230	2136	1525	1350	1762	748
20-30	4863	1220	2114	1502	1326	1744	740
30-40	4735	1179	2050	1444	1264	1709	736
40-50	4606	1144	1986	1397	1220	1682	724
50-60	4475	1110	1935	1362	1184	1638	717
60-70	4345	1075	1884	1316	1123	1602	699
70-80	4195	1029	1794	1281	1078	1566	687
80-90	4020	983	1704	1260	1043	1540	669
90-100	3815	970	1666	1200	1000	1500	600

Henderson Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)	7 Length (m)
Surface	1545	495	840	950	850	920	1145	770
0 - 5	1545	485	830	945	845	910	1135	760
5 -10	1522	470	815	925	830	895	1120	740
10-15	1481	450	805	910	820	880	1110	710
15-20	1431	430	795	895	805	860	1085	685
20-30	1353	410	775	870	780	835	1065	645
30-40	1267	380	750	835	750	810	1020	535
40-50	1187	355	715	810	725	770	990	485
50-60	1104	340	680	790	710	745	955	445
60-70	1063	320	645	765	685	710	925	410

Table 5 (cont'd)

Hobiton Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)
Surface	350	360	415	595	715	460
0 - 5	340	340	320	460	710	340
5 -10	334	340	300	460	700	330
10-15	320	340	280	450	690	300
15-20	285	300	260	440	660	280
20-30	252	280	230	400	630	260
30-40	215	220	200	360	590	180
40-50	172		120	320	550	90
50-60	25			290	510	

Depth Stratum (m)	Transect 6 Length (m)	Transect 7 Length (m)	Transect 8 Length (m)	Transect 9 Length (m)	Transect 10 Length (m)	Transect 11 Length (m)
Surface	750	910	1500	915	1090	1125
0 - 5	710	900	1310	895	1060	1120
5 -10	710	900	1310	895	1055	1100
10-15	710	890	1310	890	1040	1070
15-20	700	870	1260	880	1030	1060
20-30	655	825	1200	825	1000	1020
30-40	445	740	1130	760	960	980
40-50		550	1075	670	845	855
50-60			1015	590	785	780

Table 5 (cont'd)

Ian Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)	7 Length (m)
Surface	1903	430	535	725	1145	2075	1615	785
0 - 5	1809	410	520	701	1101	2059	1583	766
5 -10	1631	357	498	648	1001	1982	1399	652
10-15	1470	300	468	607	754	1853	1272	505
15-20	1322	237	447	553	691	1681	1148	
20-30	1146	119	407	409	580	1369	1077	
30-40	915		350		437	1260	998	
40-50	710		229		319	1100	885	
50-60	578				250	1013	790	
60-70	476							

Jansen Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)
Surface	61	250	400	475	650	1850
0 - 5	58	232	395	455	625	1798
5 -10	55	207	358	449	599	1764
10-15	51	177	342	423	574	1504
15-20	46	146	321	403	523	1452
20-30	40	110	274	358	459	1331
30-40	27	49	179	293	255	1003
40-50	15		126	228		804

Table 5 (cont'd)

Kennedy Lake (Clayoquot Arm)

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)	7 Length (m)	8 Length (m)
Surface	1480	1065	2210	1500	975	1690	1620	820	820
0 - 5	1480	1045	2195	1485	965	1680	1610	810	810
5 -10	1433	1020	2175	1465	950	1650	1580	790	790
10-15	1385	990	2150	1445	925	1620	1545	760	760
15-20	1315	960	2150	1415	905	1595	1485	725	725
20-30	1100	900	2075	1370	870	1545	1440	675	675
30-40	980	855	2020	1335	805	1465	1365	600	600
40-50	890	825	1950	1310	755	1380	1280	510	510
50-60	820	790	1920	1295	695	1265	1230	425	425
60-70	250	725	1785	1265	655	1210	1025	200	200

Depth Stratum (m)	Transect 9 Length (m)	10 Length (m)	11 Length (m)	12 Length (m)	13 Length (m)	14 Length (m)	15 Length (m)	16 Length (m)
Surface	1620	1745	730	1390	1850	1620	705	890
0 - 5	1610	1735	725	1380	1845	1610	695	880
5 -10	1580	1710	710	1355	1825	1580	680	855
10-15	1545	1670	690	1330	1800	1550	665	830
15-20	1485	1620	660	1295	1780	1520	650	805
20-30	1440	1575	630	1240	1705	1470	625	775
30-40	1365	1530	600	1180	1635	1390	575	725
40-50	1280	1435	565	1135	1610	1375	515	575
50-60	1230	1325	535	1100	1585	1335	445	395
60-70	1025	1260	500	1065	1565	1280	290	

Table 5 (cont'd)

Kennedy Lake (Main Arm)

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)	7 Length (m)
Surface	3450	1680	1950	2300	1845	2030	3770	2480
0 - 5	3450	1665	1930	2285	1830	1975	3680	2330
5 -10	3130	1645	1905	2260	1790	1885	3225	2055
10-15	2810	1625	1865	2225	1745	1785	2365	1755
15-20	2530	1605	1820	2200	1705	1690	1810	1325
20-30	1885	1570	1615	2145	1615	1545	873	505
30-40	1420	1530	1355	2075	1470	720	220	
40-50	945	1460	1220	1855	1175	65		
50-60	715	1400	1030	1605	785			
60-70	210	1370	995	1330				

Depth Stratum (m)	Transect 8 Length (m)	9 Length (m)	10 Length (m)	11 Length (m)	12 Length (m)	13 Length (m)	14 Length (m)	15 Length (m)
Surface	2480	3780	2030	1845	1765	1950	1025	1915
0 - 5	2330	3585	1975	1830	1755	1930	1015	1900
5 -10	2055	3185	1885	1790	1730	1905	1000	1870
10-15	1755	2635	1785	1745	1705	1865	985	1840
15-20	1325	2305	1690	1705	1680	1820	965	1805
20-30	505	1795	1545	1615	1630	1615	940	1765
30-40		640	720	1470	1530	1355	910	1695
40-50			65	1175	1285	1220	865	1640
50-60				785	1145	1030	810	1525
60-70					1090	995	720	1400

Table 5 (cont'd)

Long Lake (A)

	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)
Depth Stratum (m)						
Surface	1025	495	550	640	880	850
0 - 5	1025	492	548	640	877	850
5 -10	1012	478	544	640	873	834
10-15	999	456	539	638	866	821
15-20	975	438	535	626	854	798
20-30	955	405	517	602	839	763
30-40	905	388	479	577	821	724
40-50	805	329	441	545	802	678
50-60	625	280	403	500	770	640
60-70	575	260	380	450	740	615

Long Lake (B)

	Stratum Area (ha)	Transect 6 Length (m)	Transect 7 Length (m)	Transect 8 Length (m)	Transect 9 Length (m)
Stratum (m)					
Surface	1075	1115	985	1575	1005
0 - 5	1075	1105	982	1572	1003
5 -10	1075	1088	969	1561	999
10-15	1070	1072	957	1543	986
15-20	1065	1060	944	1525	958
20-30	1010	1042	922	1492	927
30-40	965	1015	899	1437	888
40-50	908	990	867	1390	846
50-60	853	967	847	1343	819
60-70	810	910	790	1310	760

Long Lake is comprised of Basin's A and B.

Table 5 (cont'd)

Lowe Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)
Surface	383	865	695	630	965
0 - 5	358	835	673	615	946
5 -10	318	805	655	598	901
10-15	77	670	632	571	843
15-20	65		600	530	811
20-30	47		563	486	756
30-40	23		495	412	627
40-50	6		333	254	450
50-60					

Mercer Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)
Surface	104	500	390	415	225
0 - 5	93	486	373	391	210
5 -10	77	429	359	358	188
10-15	65	400	324	316	139
15-20	47	371	291	258	79
20-30	23	297	173		
30-40	6				

Table 5 (cont'd)

Muchalat Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)
Surface	642	650	1650	500	650	550
0 - 5	623	644	1650	500	632	550
5 -10	584	632	1633	474	614	536
10-15	550	565	1600	439	595	523
15-20	522	541	1575	412	577	509
20-30	475	407	1525	368	540	475
30-40	402	352	1458	237	504	441
40-50	311	176	1258	79	458	394
50-60	164		805		370	326

Muriel Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)
Surface	145	350	550	400	840	840
0 - 5	135	347	550	400	827	840
5 -10	115	325	532	376	763	804
10-15	97	246	450	350	662	779
15-20	80	92	410	256	487	759
20-30	54		325	215	289	423
30-40	27		262	168	144	307
40-50	9					236

Table 5 (cont'd)

Nimpkish Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)	6 Length (m)	7 Length (m)	8 Length (m)
Surface	3653	810	1365	1285	1730	1775	1860	1555	1130
0 - 5	3628	806	1344	1269	1702	1729	1843	1537	1093
5 -10	3604	799	1331	1254	1679	1712	1838	1522	1049
10-15	3554	791	1330	1246	1657	1700	1819	1505	973
15-20	3424	731	1282	1225	1646	1690	1796	1481	891
20-30	3282	656	1184	1184	1617	1664	1773	1440	763
30-40	3104	576	1162	1144	1573	1627	1738	1390	685
40-50	2976	512	1106	1109	1528	1582	1708	1351	612
50-60	2865	452	995	1074	1461	1544	1668	1307	551
60-70	2727		970	1044	1421	1508	1627	1275	504
70-80	2607		950	1014	1380	1465	1564	1244	464

Port John Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	2 Length (m)	3 Length (m)	4 Length (m)	5 Length (m)
Surface	91	400	400	333	300	265
0 - 5	85	400	400	330	300	265
5 -10	75	374	373	315	276	265
10-15	67	342	345	268	240	256
15-20	61	303	327	207	120	218
20-30	42	161	209	153		161
30-40	19		64	108		
40-50	13			54		

Table 5 (cont'd)

Sproat Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)
Surface	3775	630	1060	1060	1650	1150
0 - 5	3775	630	1060	1060	1650	1150
5 -10	3725	630	1060	1060	1650	1150
10-15	3675	620	1054	1048	1642	1140
15-20	3580	610	1050	1027	1640	1130
20-30	3375	600	1042	1010	1631	1120
30-40	3070	540	1000	990	1590	1090
40-50	2875	520	956	950	1540	1060
50-60	2645	480	933	940	1430	1030
60-70	2465	460	930	930	1350	960
70-80	1410	427	913	910	1250	875

Depth Stratum (m)	Transect 6 Length (m)	Transect 7 Length (m)	Transect 8 Length (m)	Transect 9 Length (m)	Transect 10 Length (m)	Transect 11 Length (m)
Surface	860	765	1500	1025	1360	1400
0 - 5	860	765	1500	1025	1540	1400
5 -10	82›	760	1490	1000	1410	1380
10-15	800	755	1485	955	1300	1270
15-20	755	750	1480	935	1300	1050
20-30	750	725	1440	890	1110	1030
30-40	385	695	1400	840	1070	820
40-50	290	660	1360	735	958	593
50-60	225	640	1310	665	884	300
60-70	185	560	1295	605	820	
70-80			1285		710	

Table 5 (cont'd)

Woss Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)
Surface	1366	1265	1495	865	760	625
0 - 5	1291	1253	1487	852	743	593
5 -10	1285	1238	1472	836	726	508
10-15	1236	1088	1450	811	700	473
15-20	1188	971	1411	786	667	444
20-30	1118	793	1360	756	638	414
30-40	1030	731	1269	714	608	366
40-50	951	665	1139	664	545	305
50-60	870	612	1049	630	502	270

Yakoun Lake

Depth Stratum (m)	Stratum Area (ha)	Transect 1 Length (m)	Transect 2 Length (m)	Transect 3 Length (m)	Transect 4 Length (m)	Transect 5 Length (m)	Transect 6 Length (m)	Transect 7 Length (m)
Surface	818	855	1145	920	1105	1155	1085	965
0 - 5	781	812	1145	892	1092	1140	1061	957
5 -10	711	727	1098	865	1073	1119	1005	941
10-15	640	684	1051	823	1054	1097	876	812
15-20	567	620	996	795	1035	1075	780	684
20-30	475	520	769	761	1003	1017	587	595
30-40	350	235	510	629	953	835	426	402
40-50	239		392	546	908	516	113	153
50-60	174		353	450	800	465	40	
60-70	132			344	691	330		

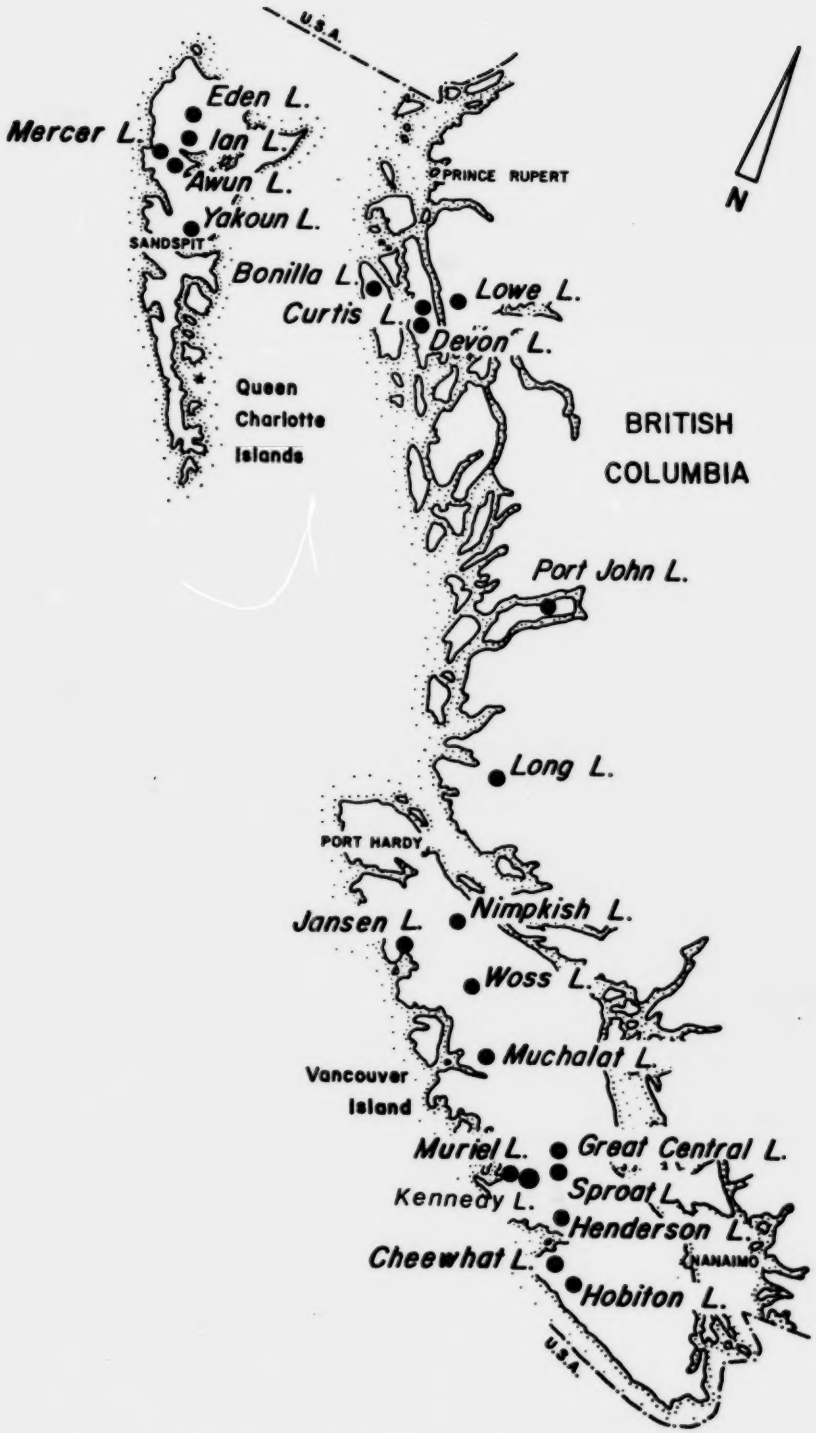
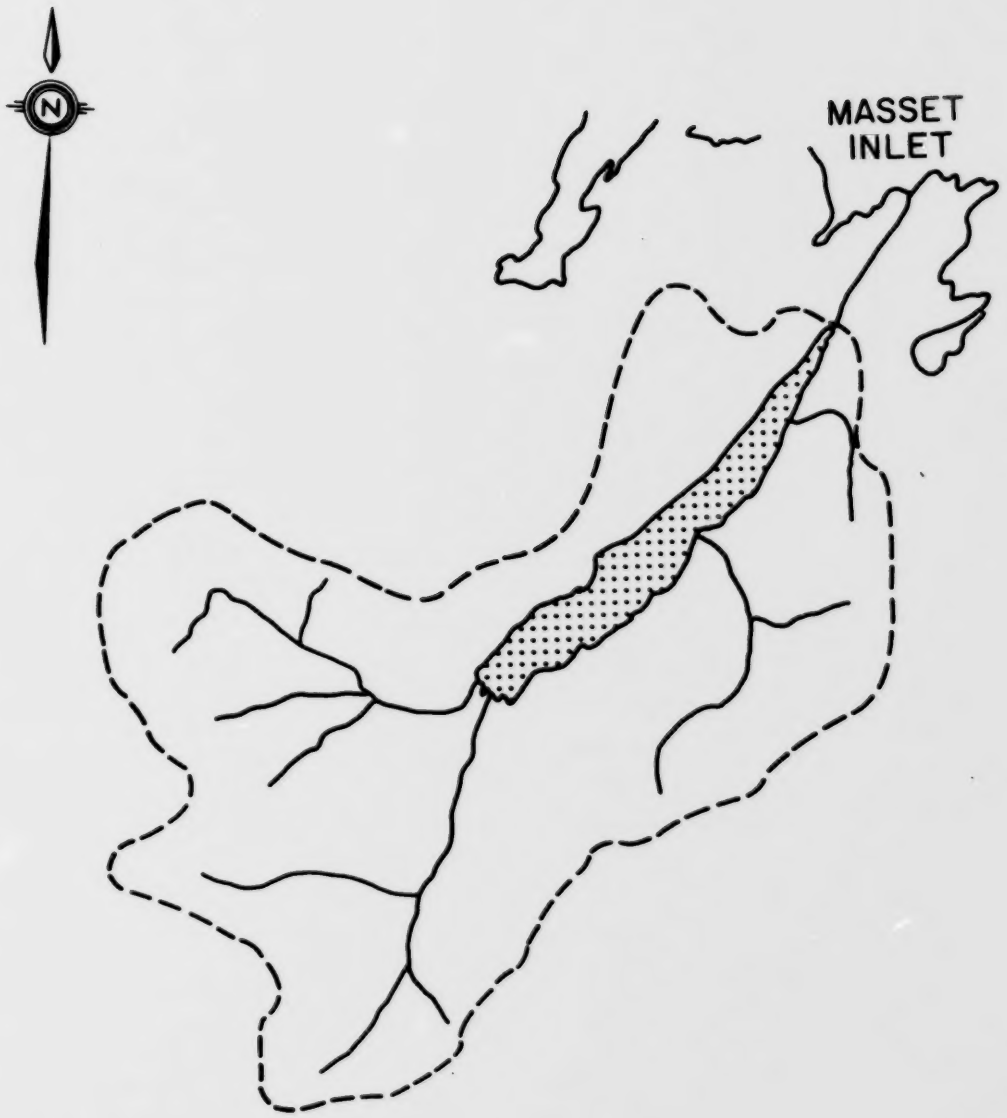


Fig. 1. Distribution of British Columbia coastal lakes currently under study by the Enhancement Assessment Unit.

Fig. 2. Separate maps of (1) watershed boundary, (2) topography, (3) bathymetry and (4) hydroacoustic transects for each of the following lakes: Awun, Bonilla, Cheewhat, Curtis, Devon, Eden, Great Central, Henderson, Hobiton, Ian, Jansen, Kennedy, Long, Lowe, Mercer, Muchalat, Muriel, Nimpkish, Port John, Sproat, Woss and Yakoun.



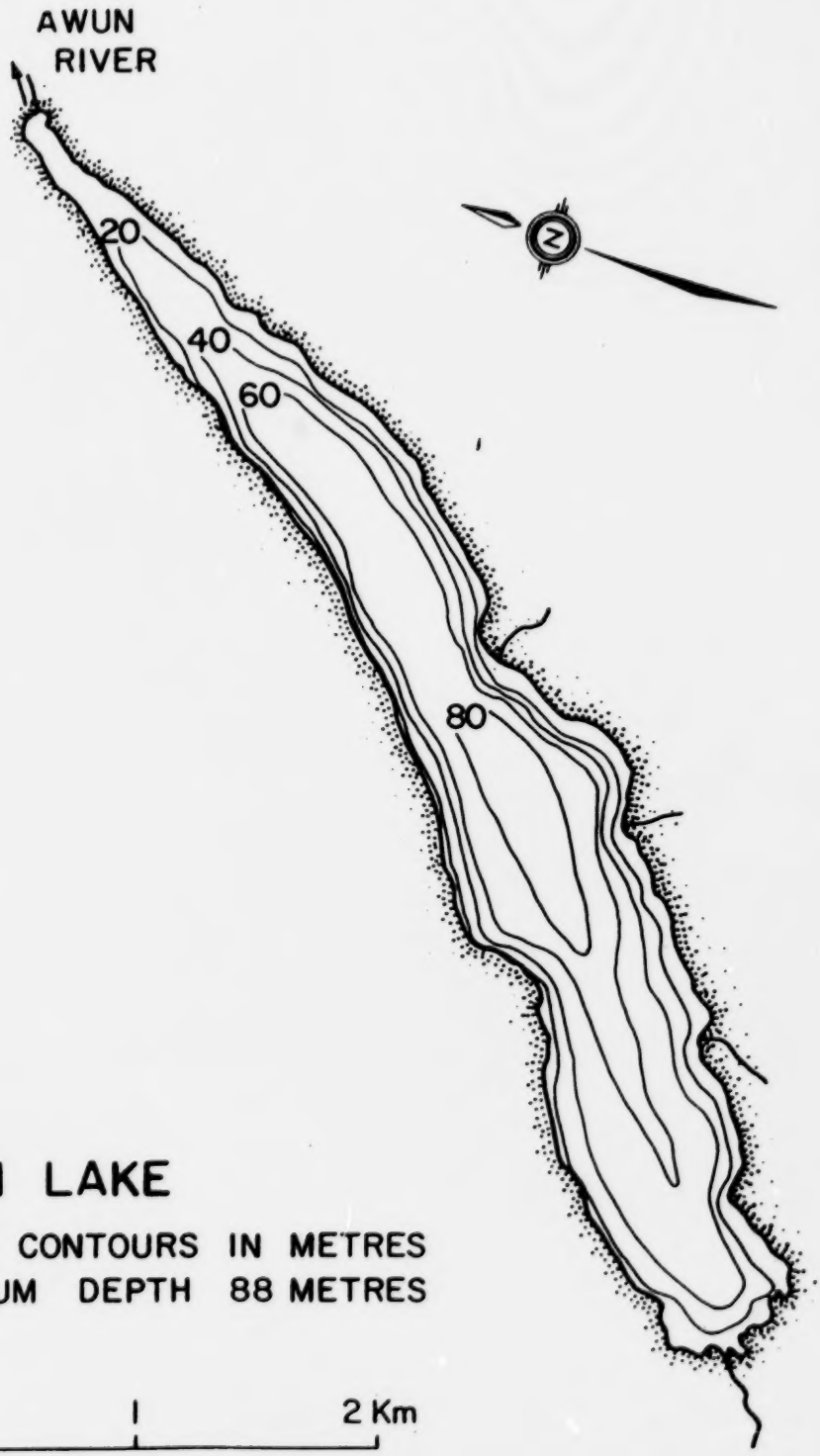
AWUN LAKE

0 1 2 3 Km

AWUN LAKE

CONTOUR LINES IN METRES

0 1 2 3 Km



AWUN LAKE

DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 88 METRES

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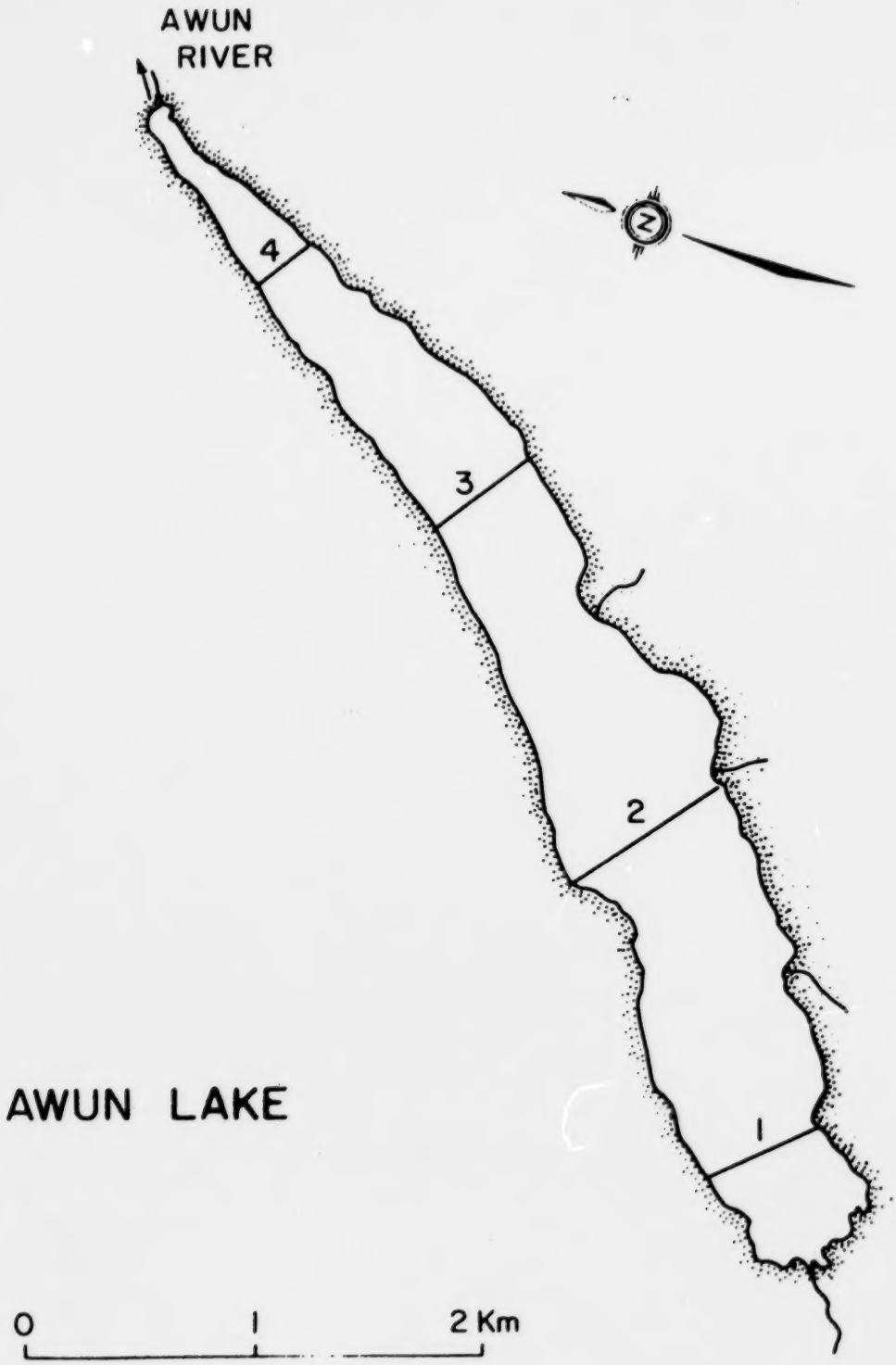
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3
2
1
AWUN LAKE
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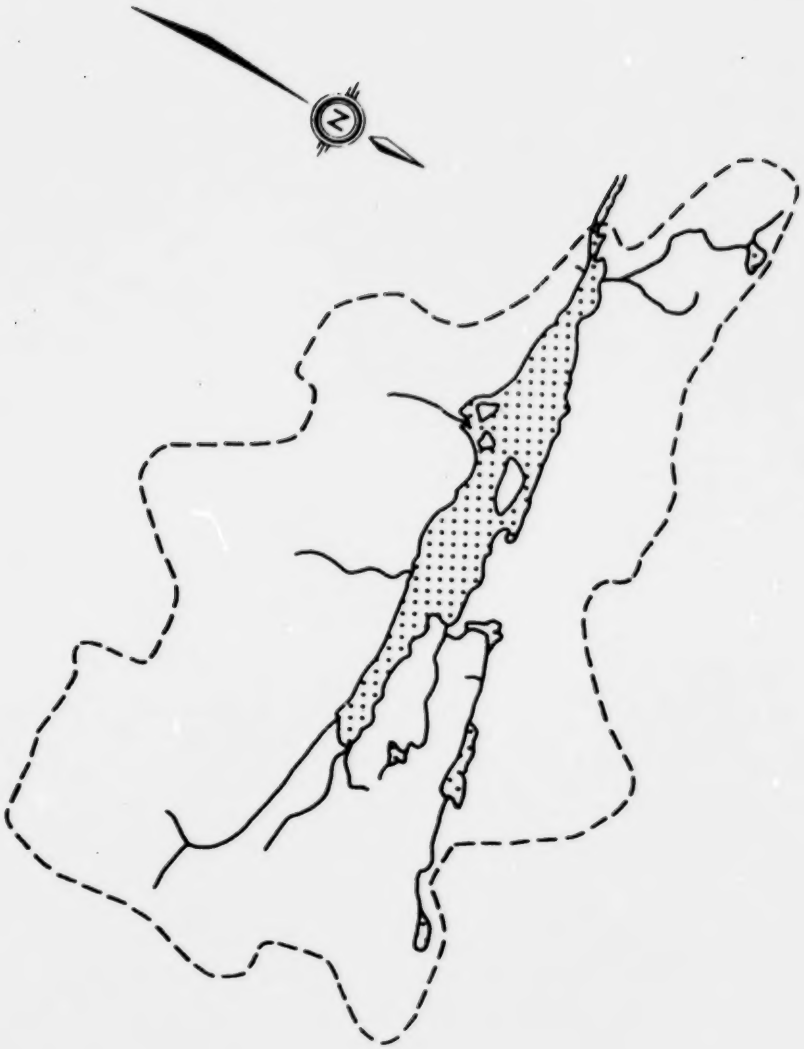
1
2 Km



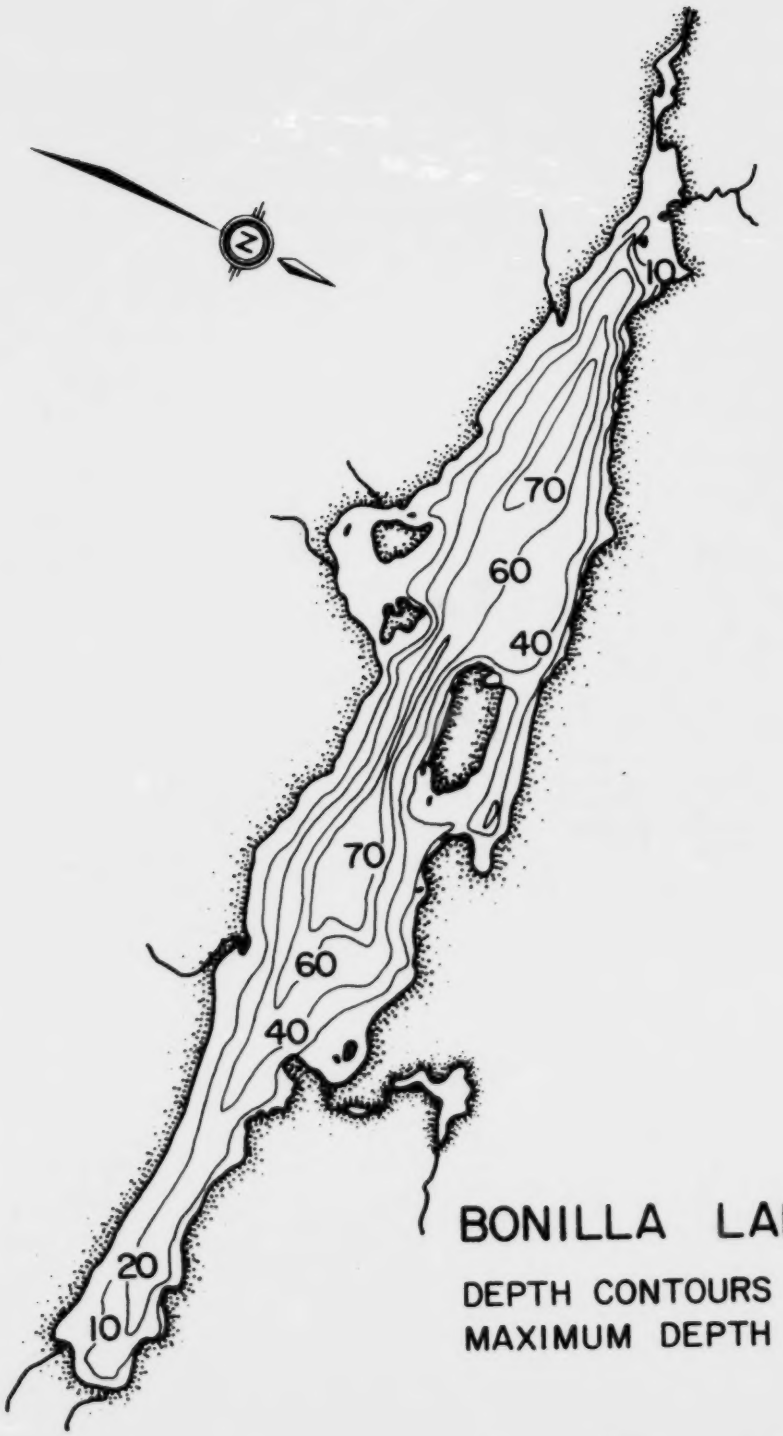
BONILLA LAKE

0 3 Km

BONILLA LAKE

CONTOUR LINES IN METRES

0 3 Km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70
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DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 80 METRES
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1 Km

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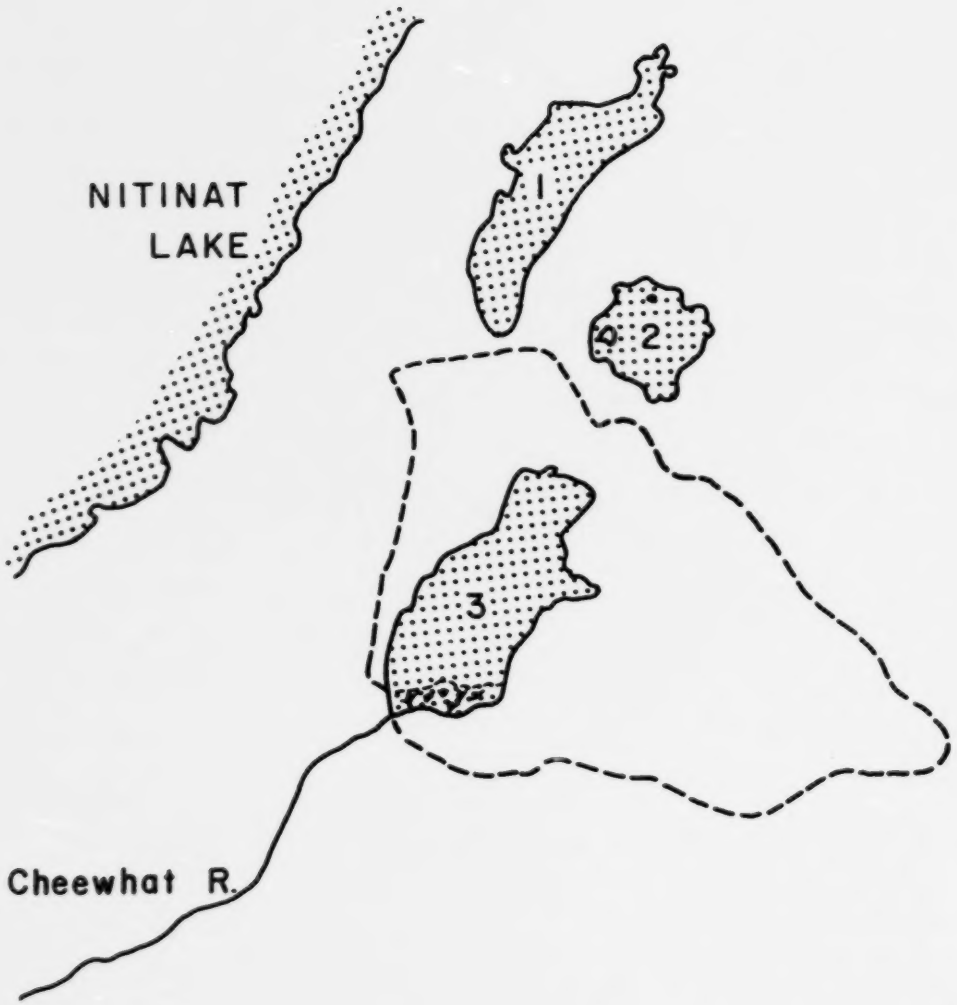
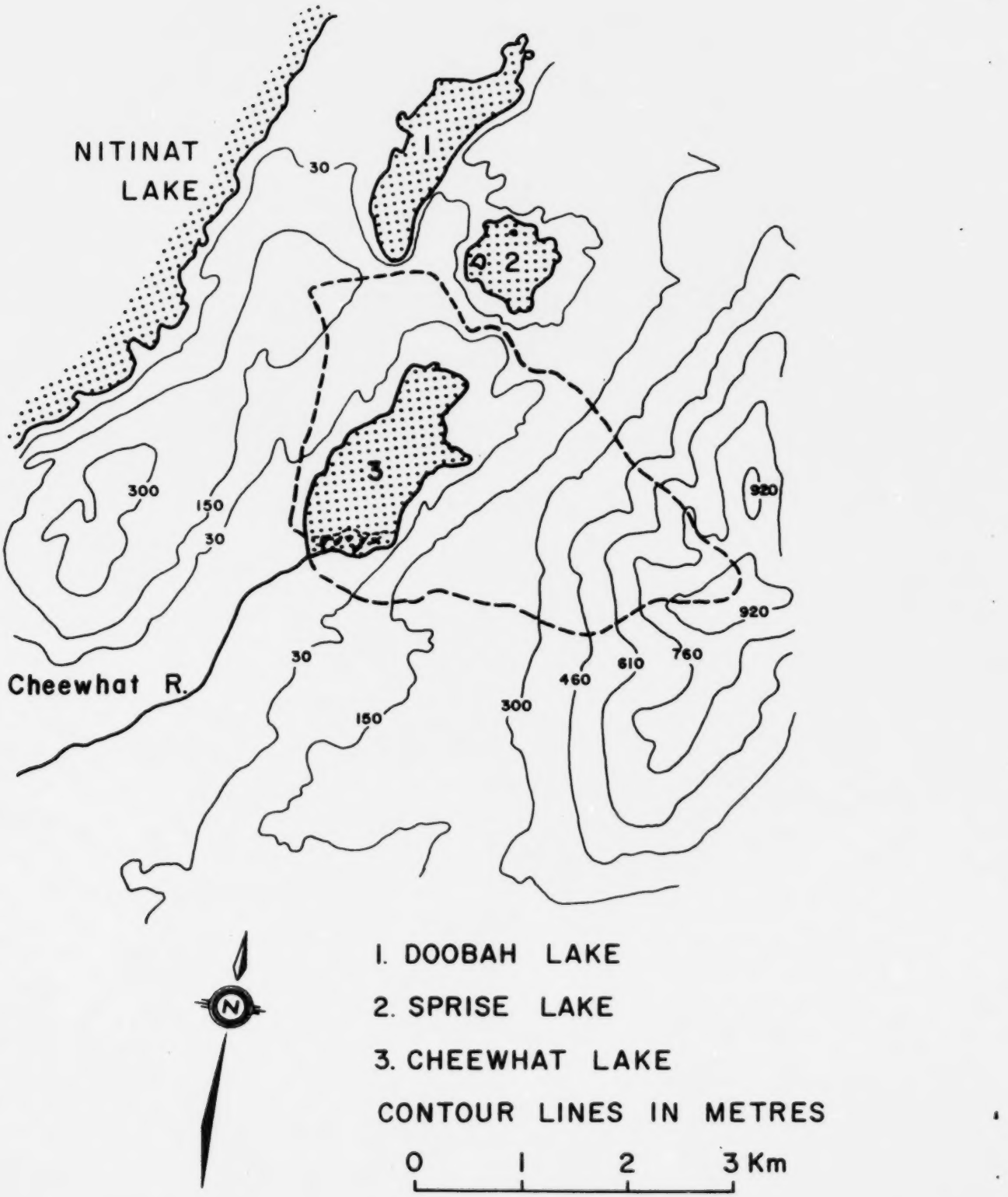
1
2
3
4
BONILLA LAKE
0
0.5
1 Km



1. DOOBAH LAKE
2. SPRISE LAKE
3. CHEEWHAT LAKE

0 1 2 3 Km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LAKE
Cheewhat R.
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30
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150
300
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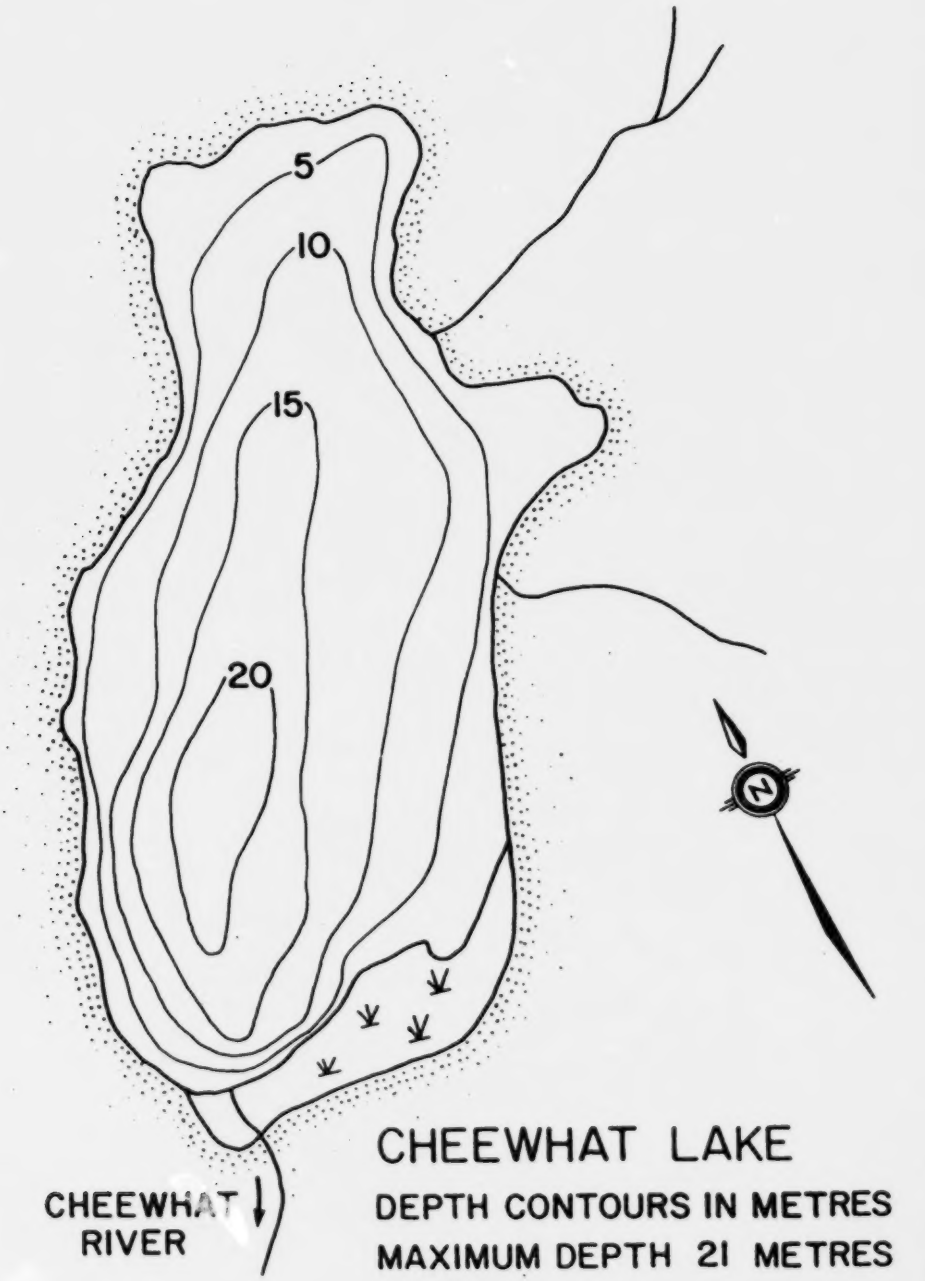
N
1. DOOBAH LAKE
2. SPRISE LAKE
3. CHEEWHAT LAKE
CONTOUR LINES IN METRES
0 1 2 3 Km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RIVER
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MAXIMUM DEPTH 21 METRES
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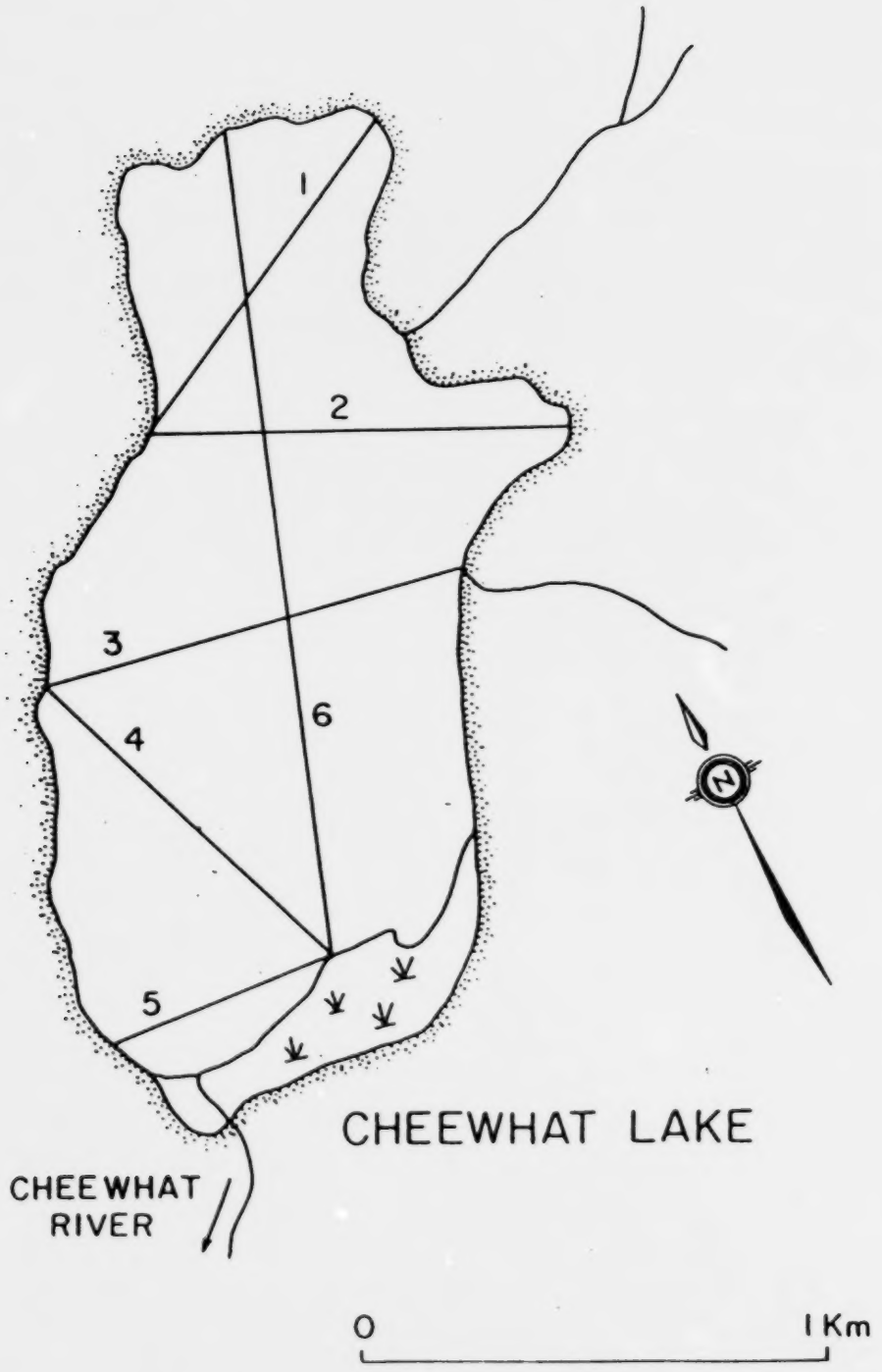
1 Km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CHEEWHAT
RIVER
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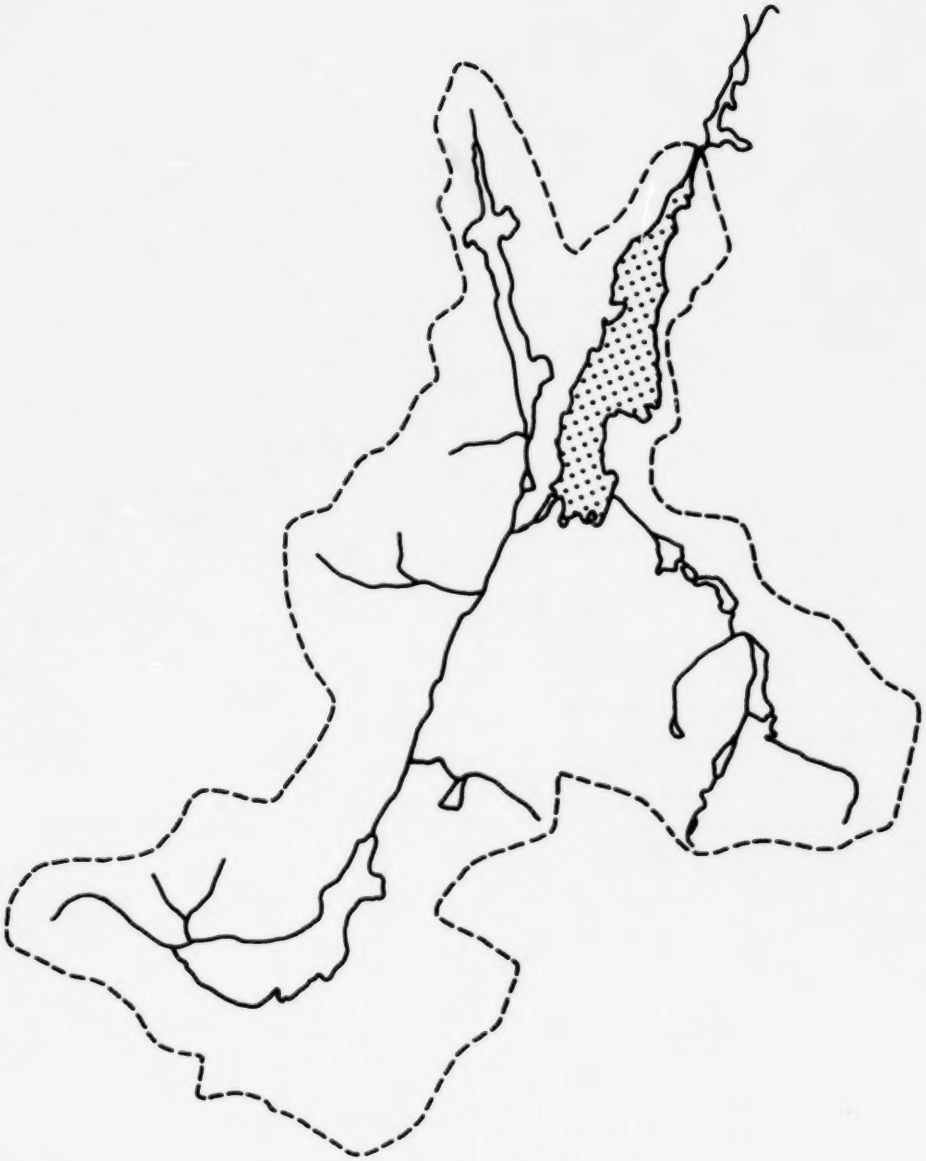
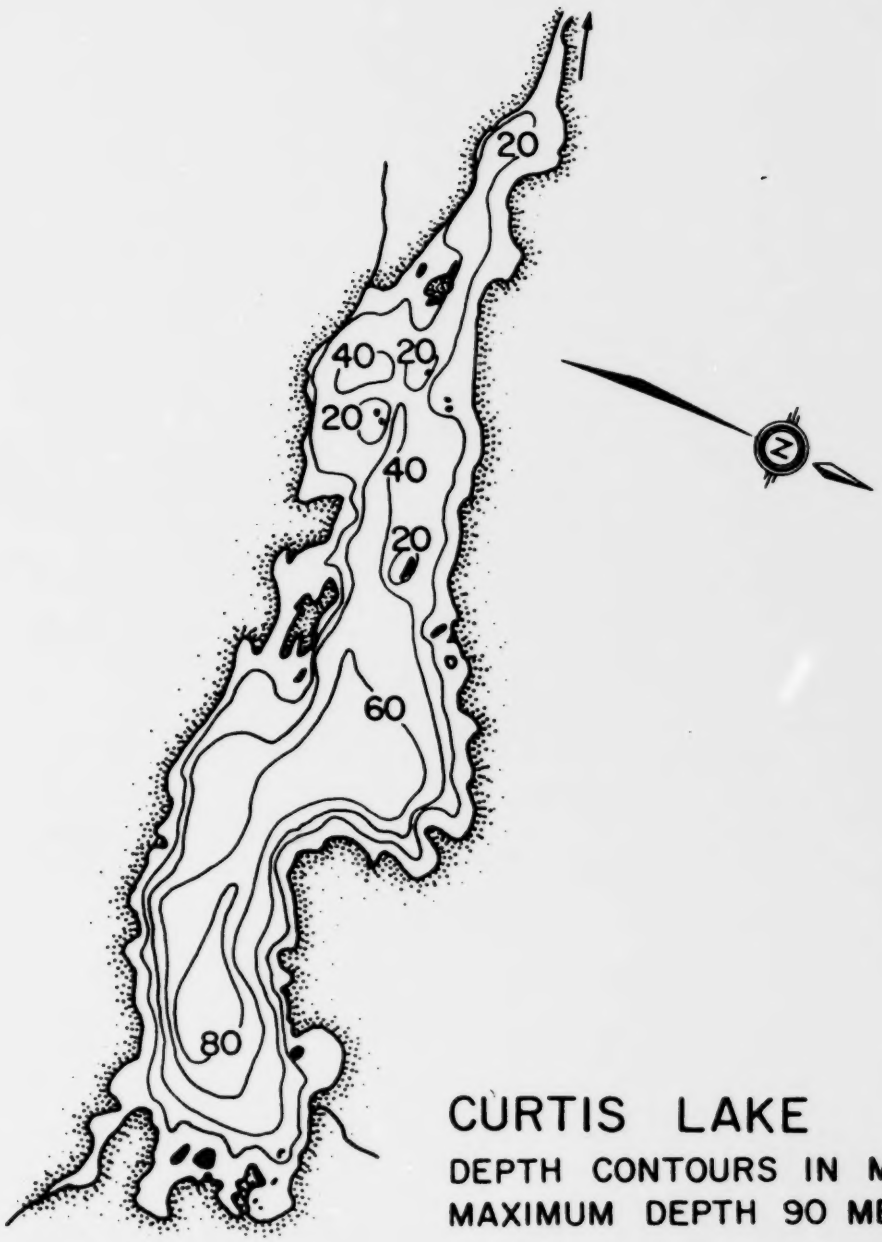


CURTIS LAKE

CURTIS LAKE

CONTOUR LINES IN METRES

0 1 2 3 Km



CURTIS LAKE

DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 90 METRES

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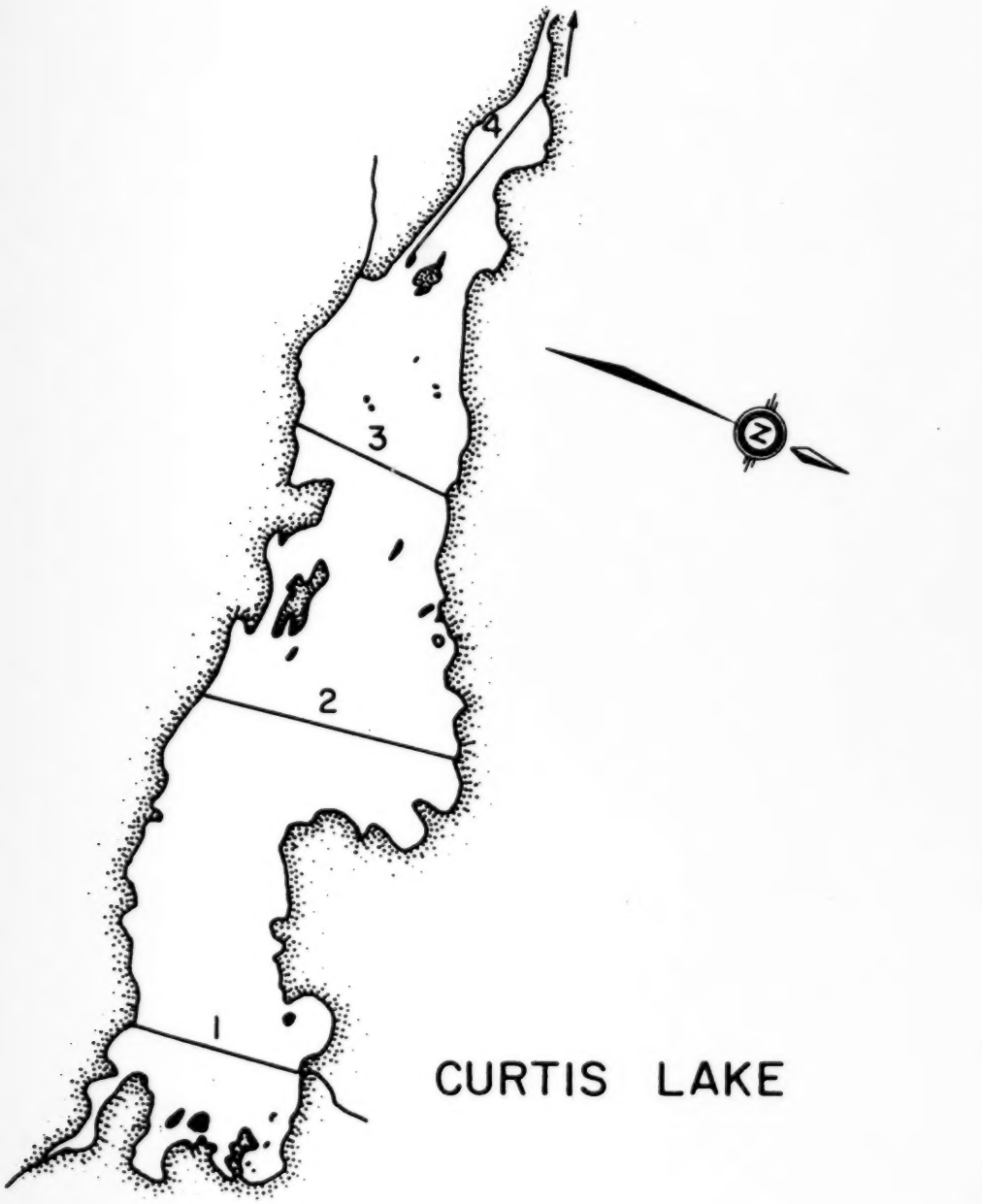
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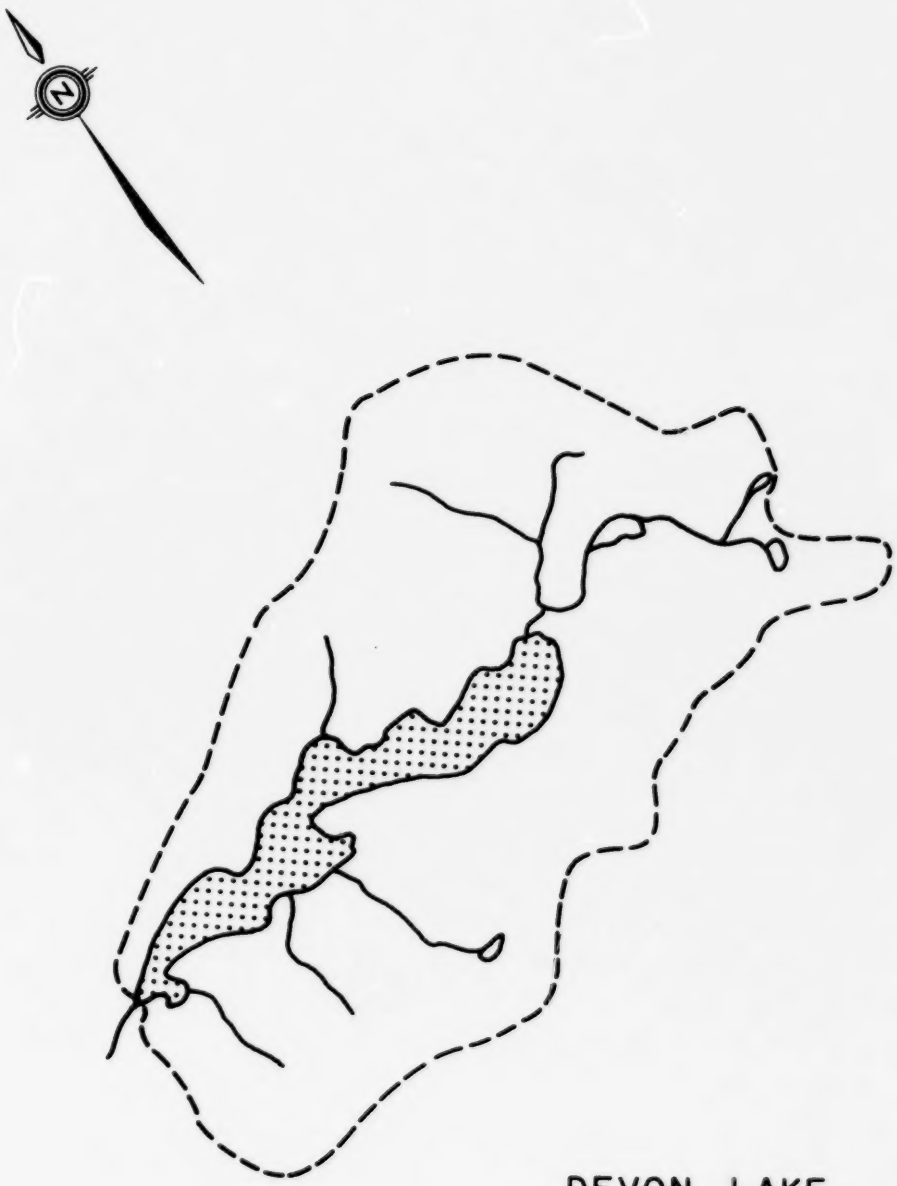
2 Km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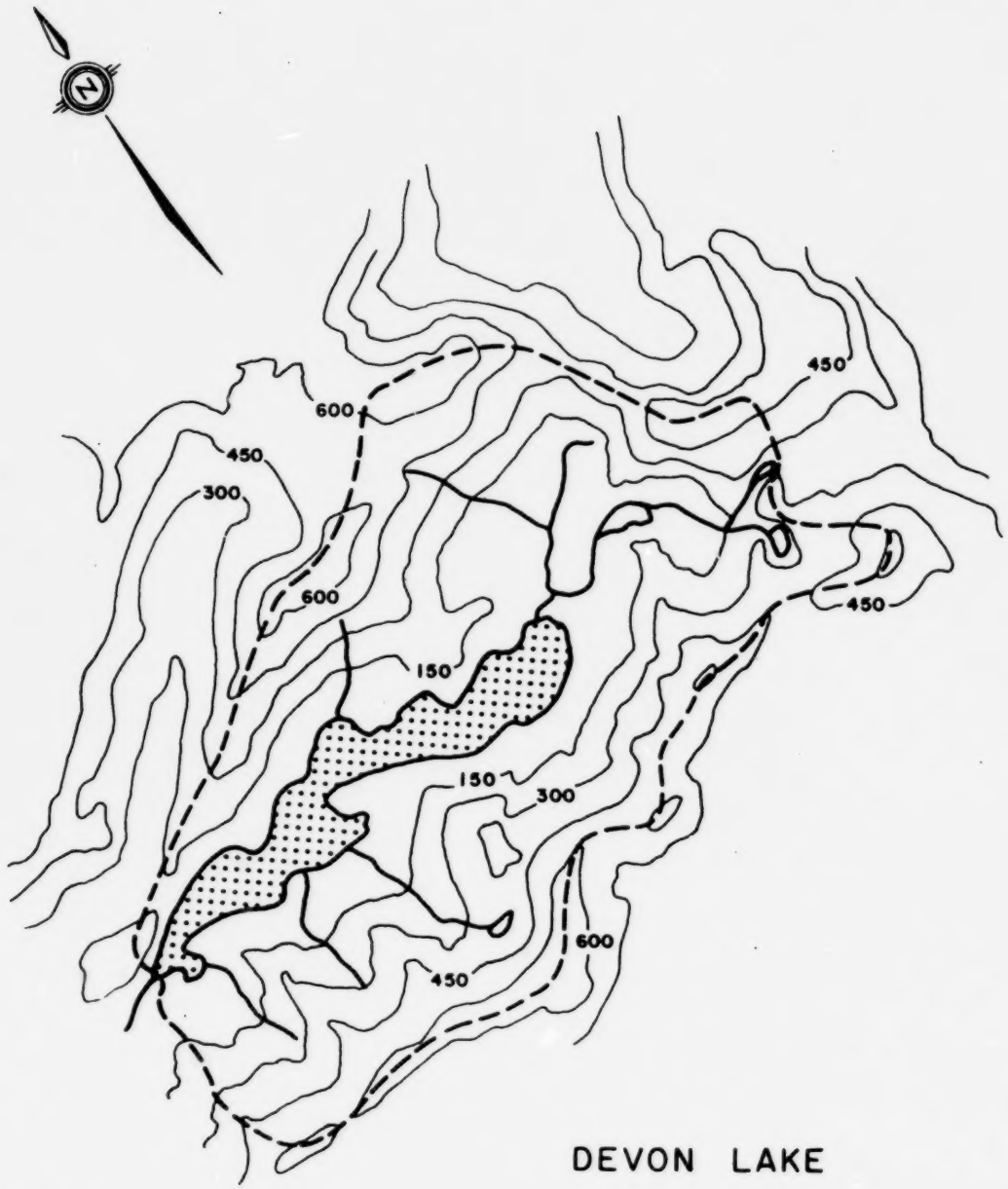
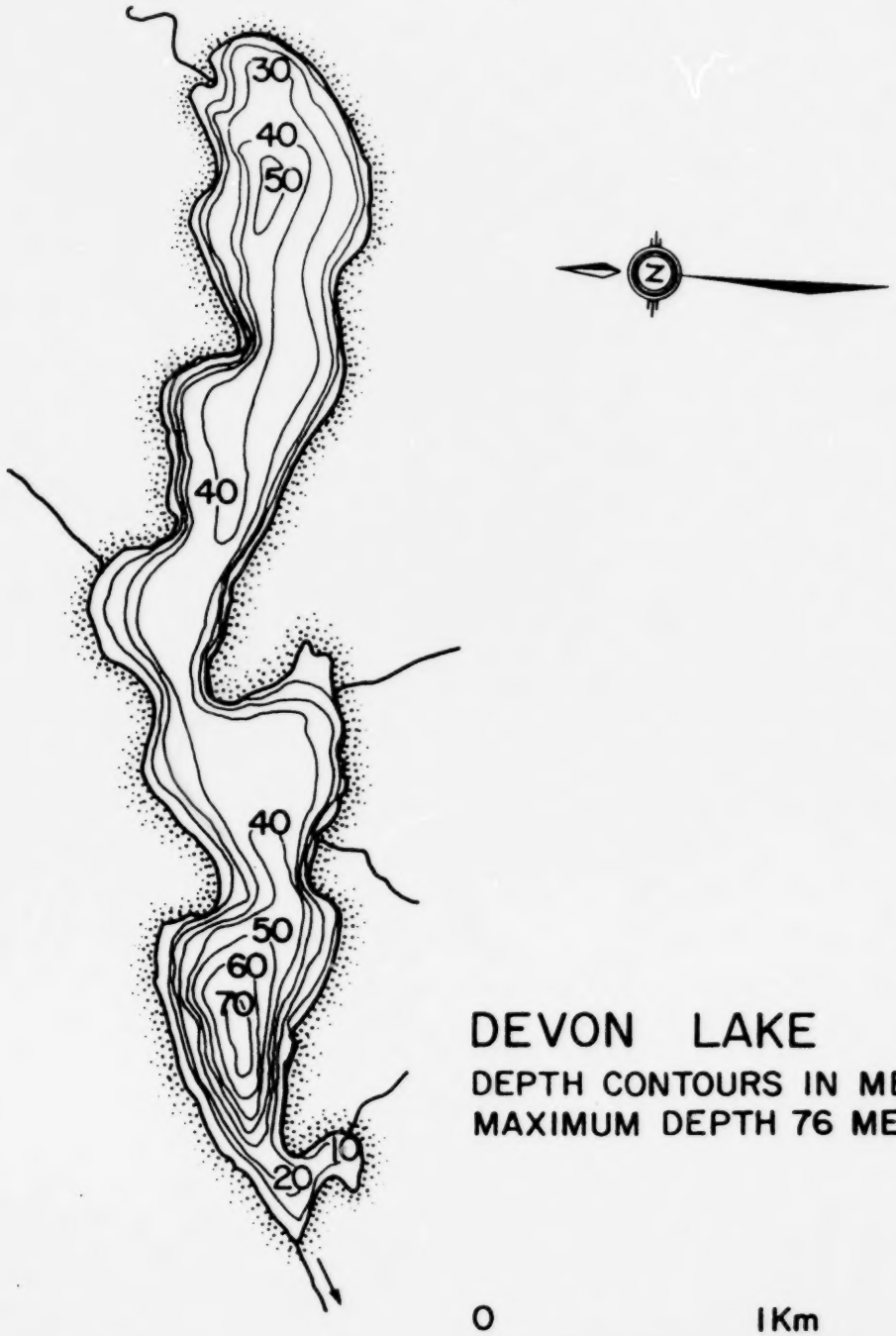
2 Km



DEVON LAKE

CONTOUR LINES IN METRES

0 1 2 Km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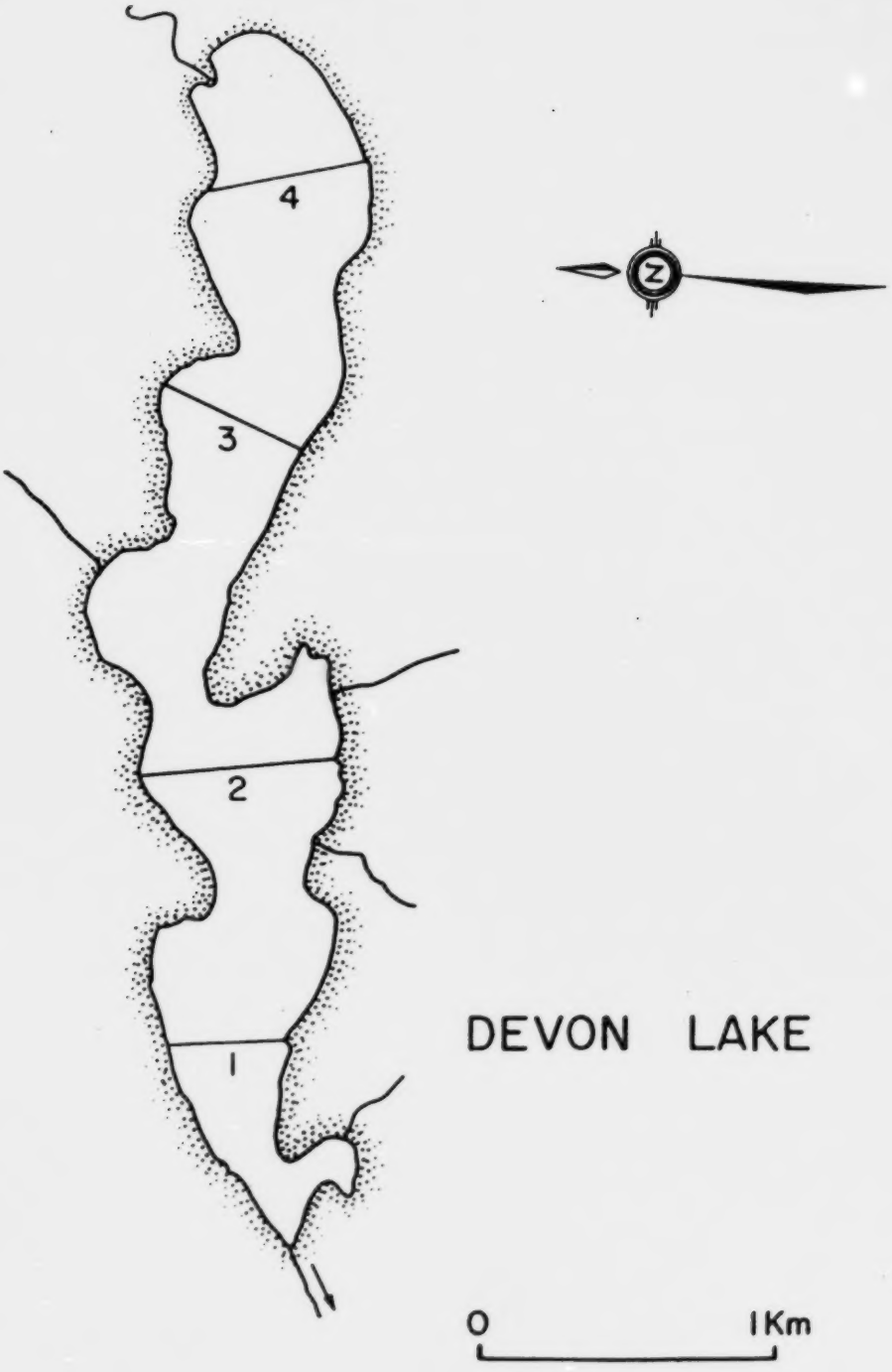
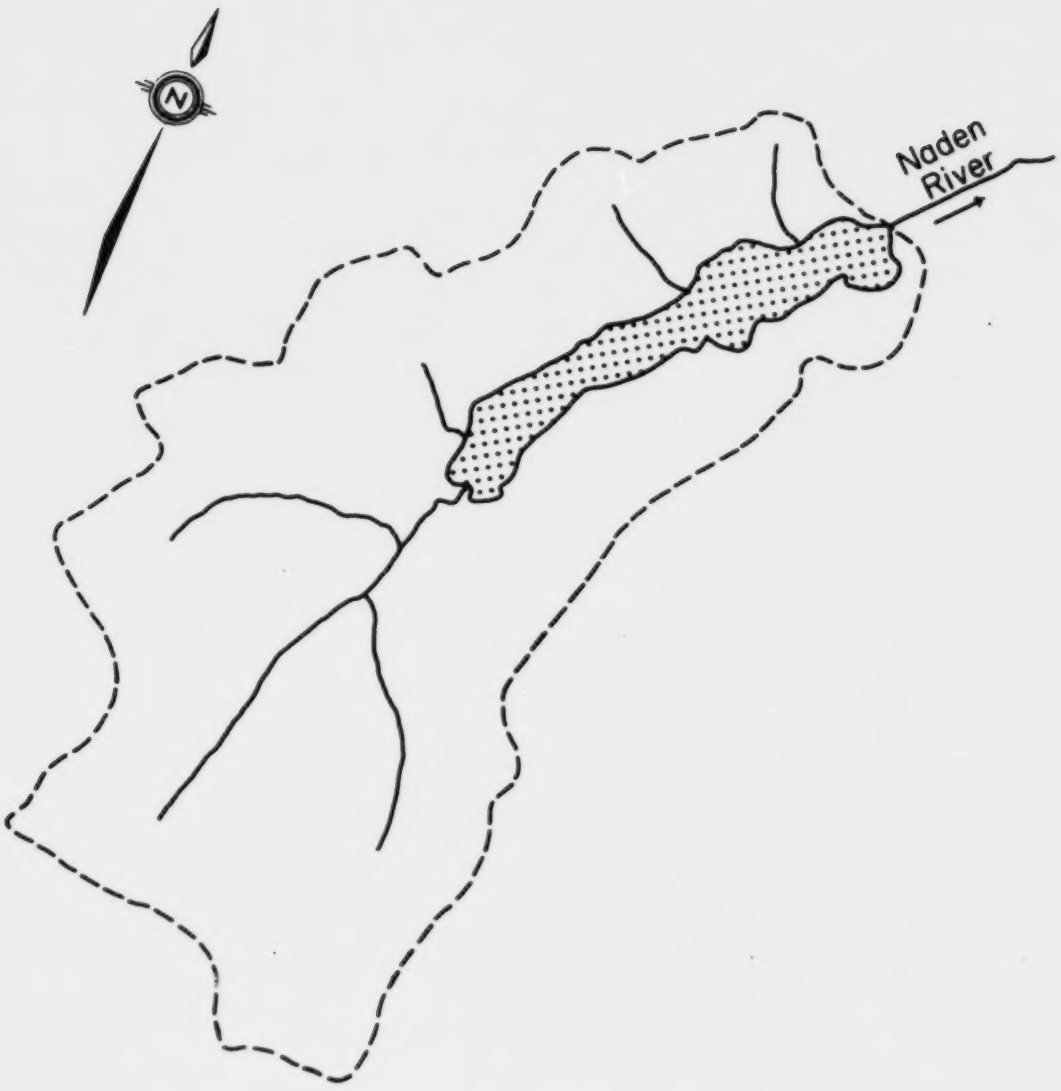
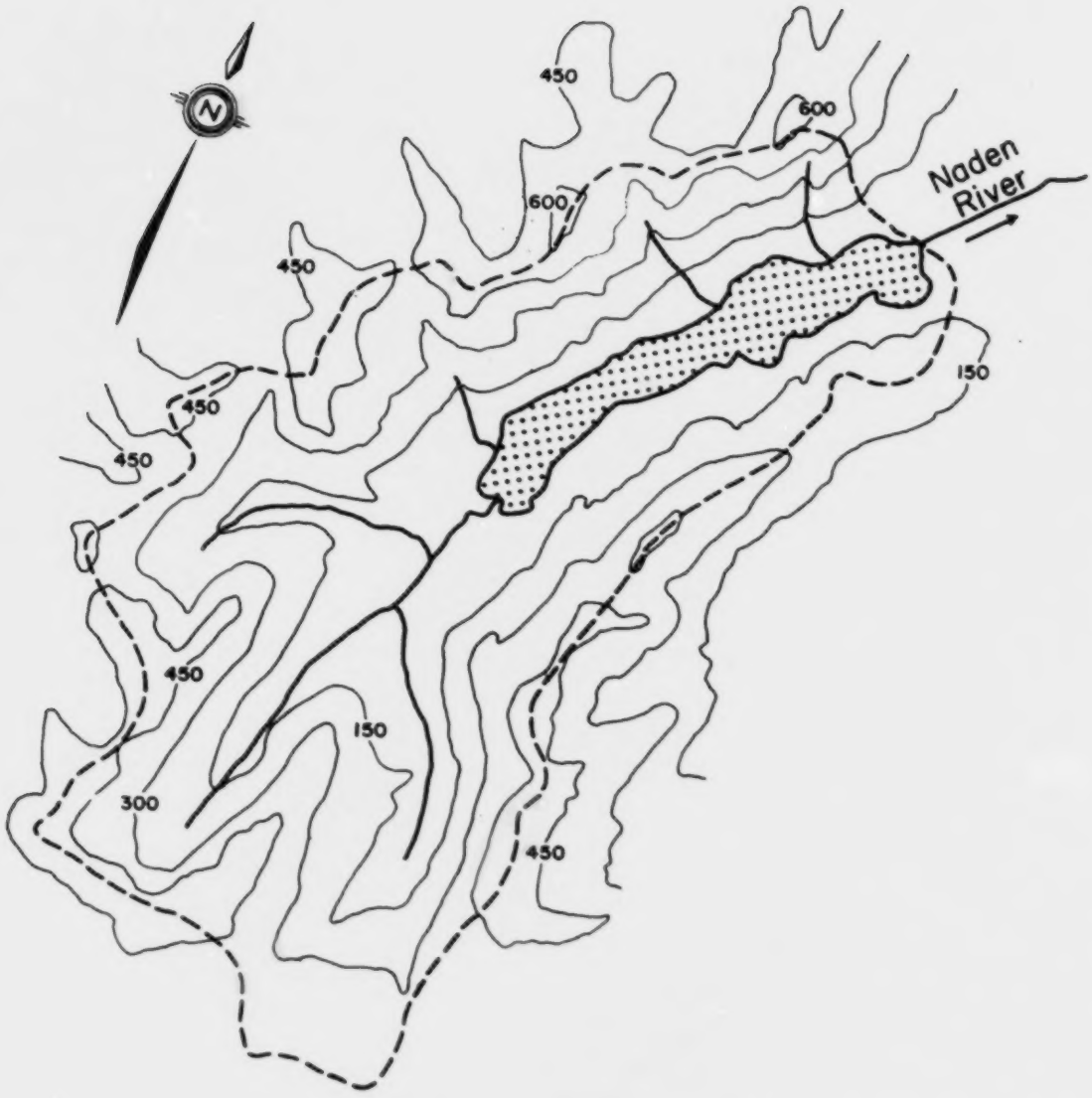
20
DEVON LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 76 METRES
0
1Km


4
3
2
1
N
DEVON LAKE
0
1Km



EDEN LAKE

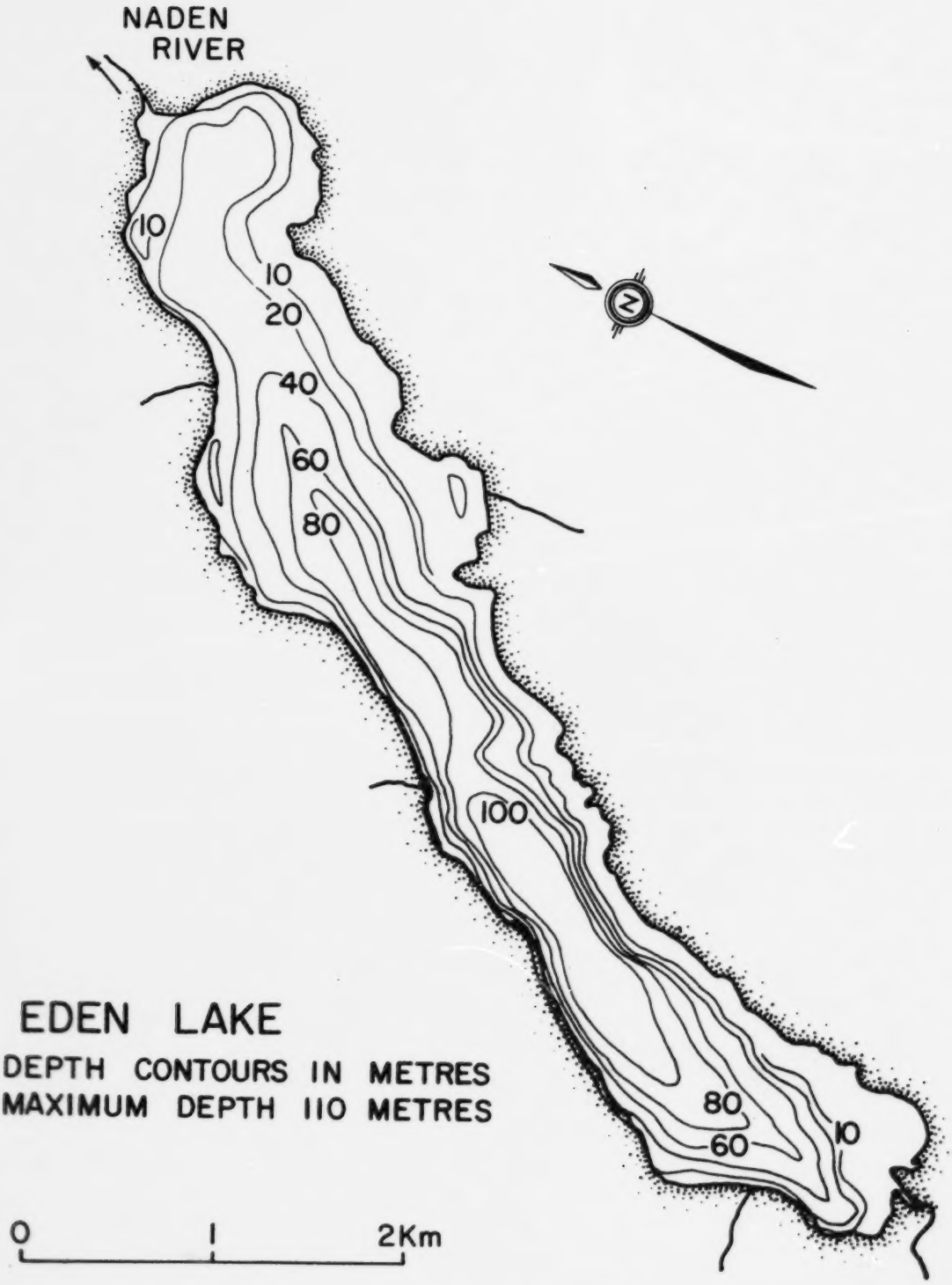
0 3 Km

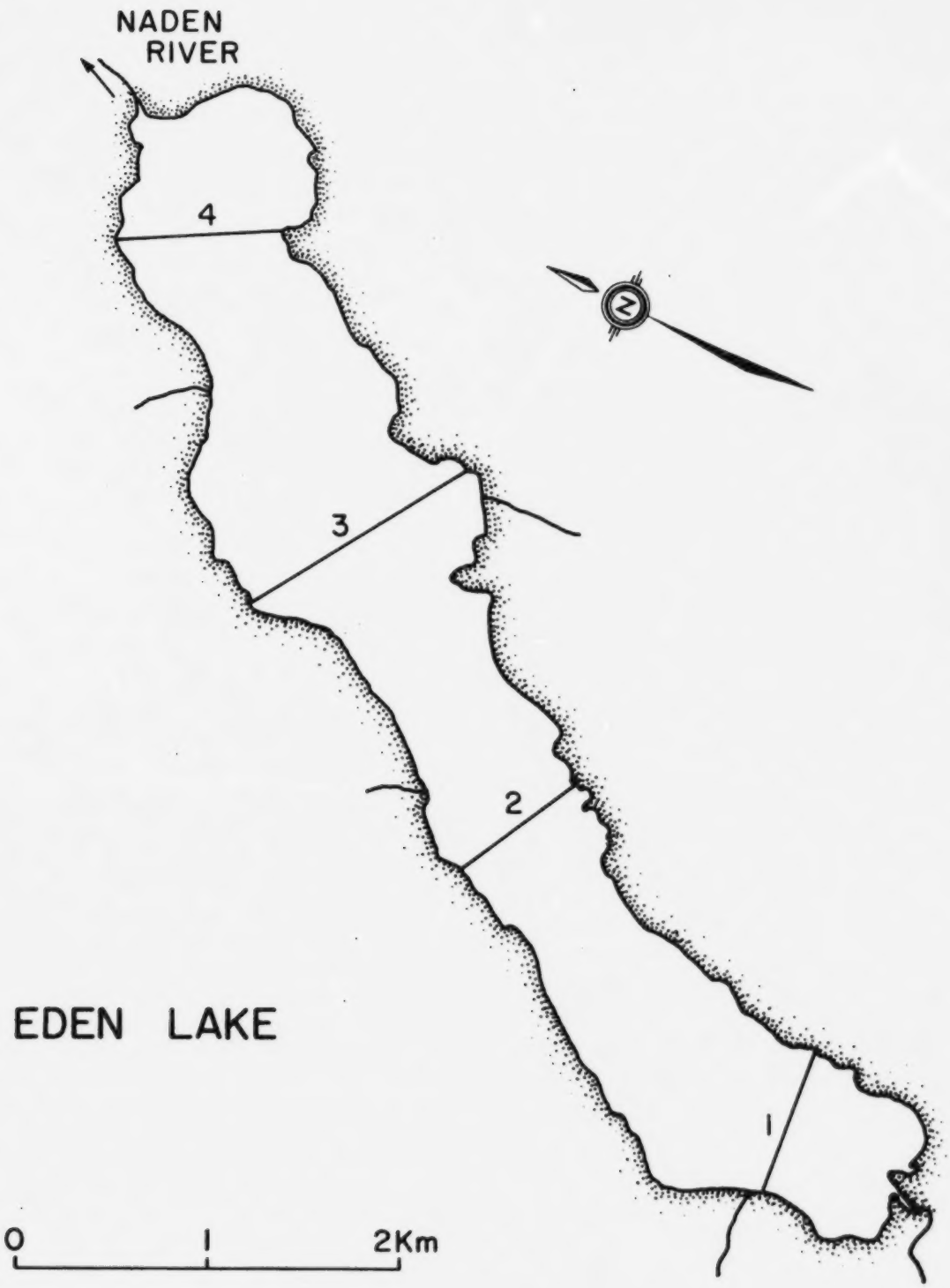


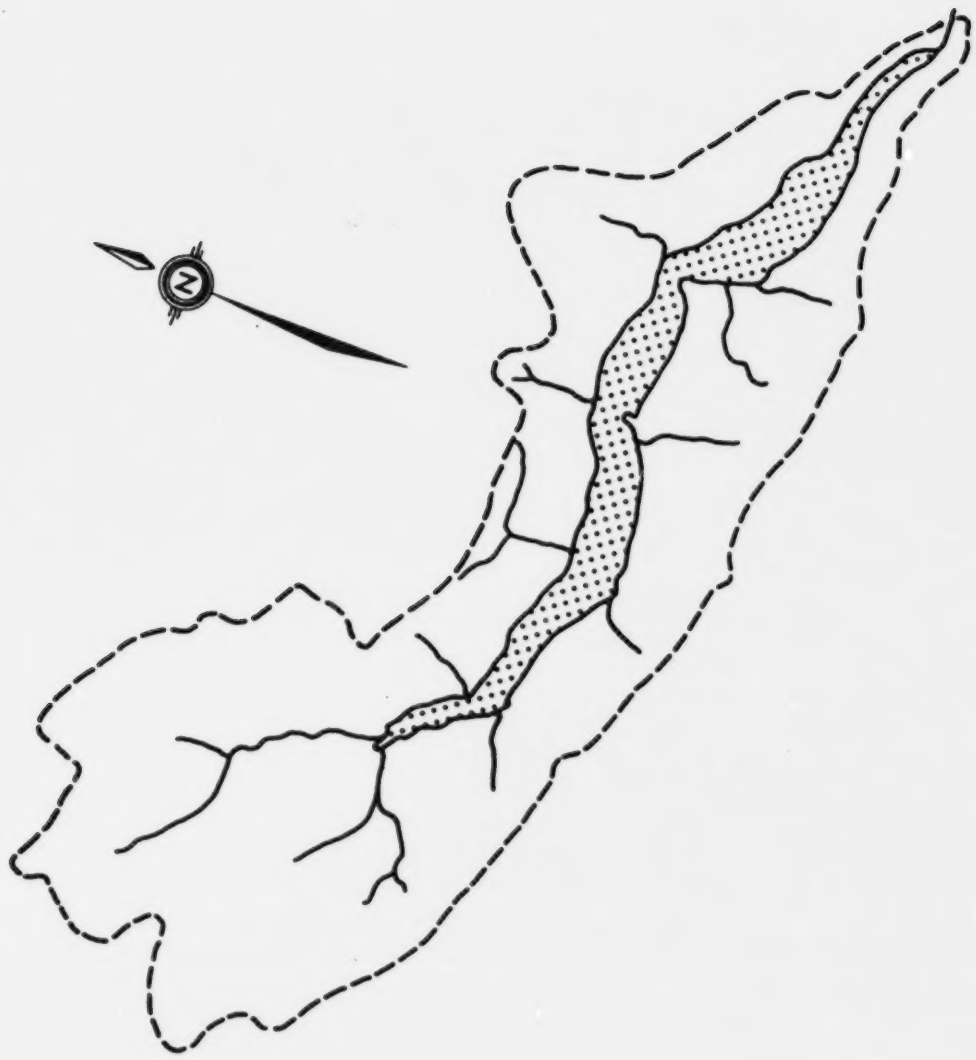
EDEN LAKE

CONTOUR LINES IN METRES

0 3 Km

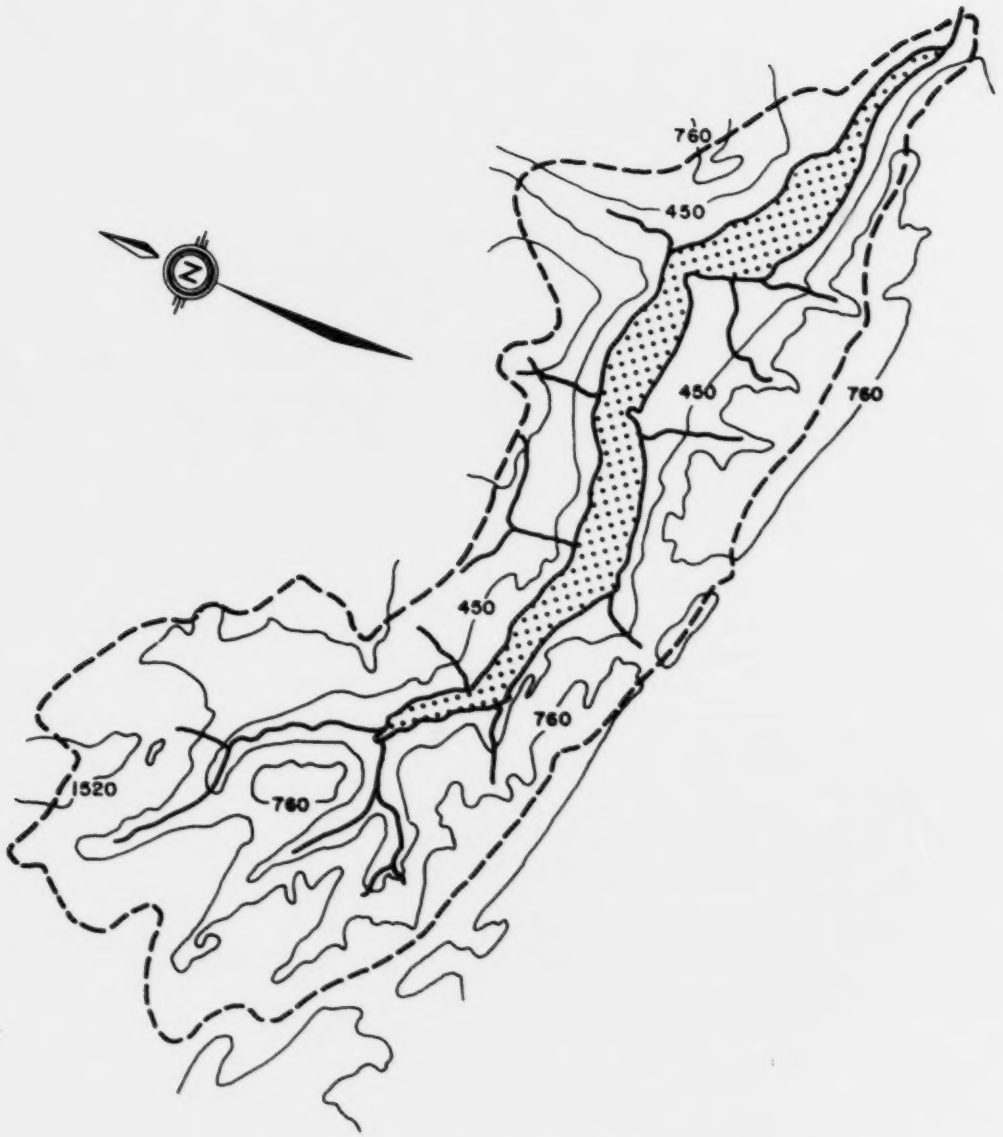

NADEN
RIVER
10
10
20
40
60
80
100
80
60
10
N
EDEN LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 110 METRES
0
1
2Km


NADEN
RIVER
4
3
2
1
N
EDEN LAKE
0
1
2Km



GREAT CENTRAL LAKE

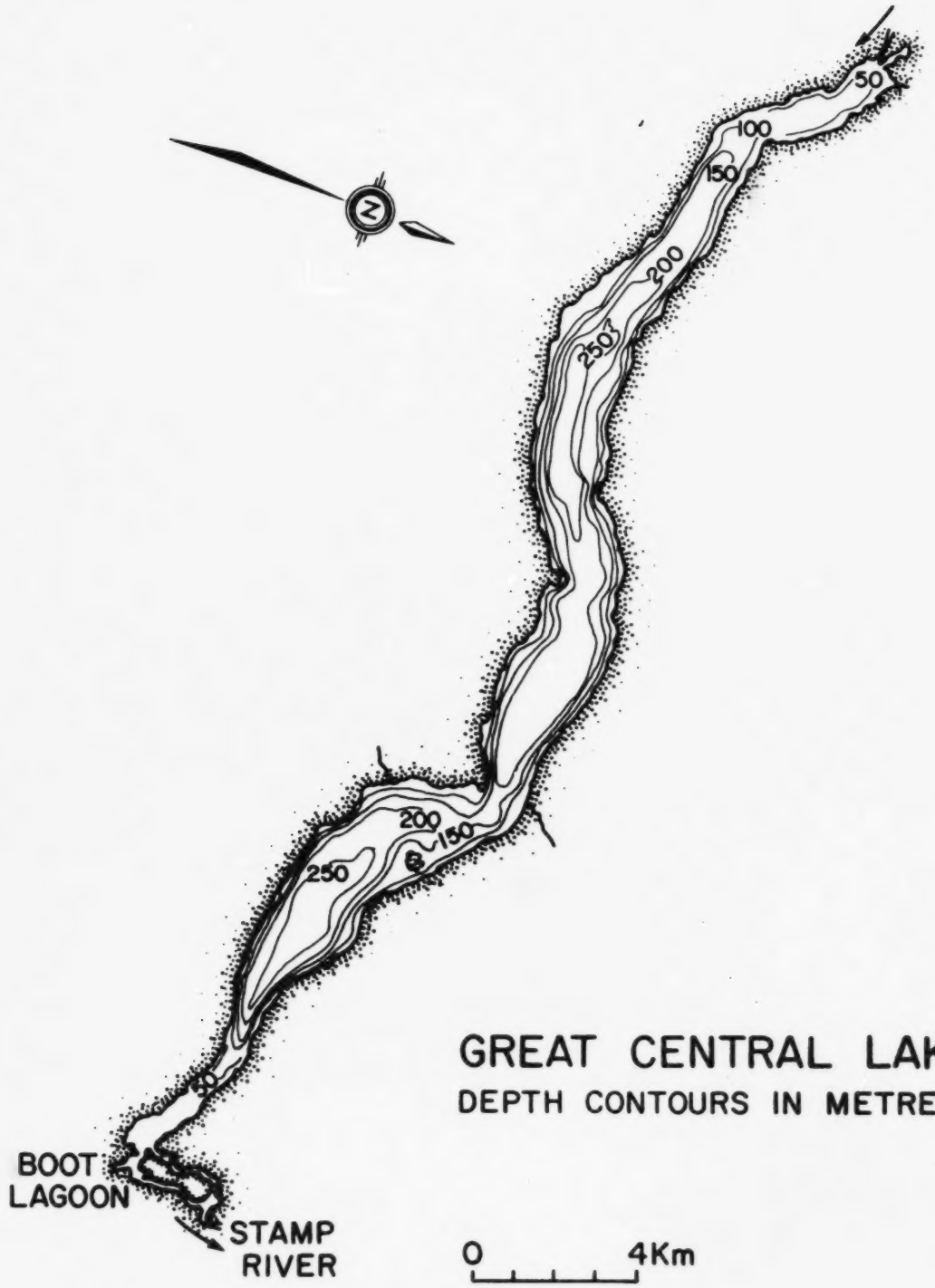
0 5 10 Km



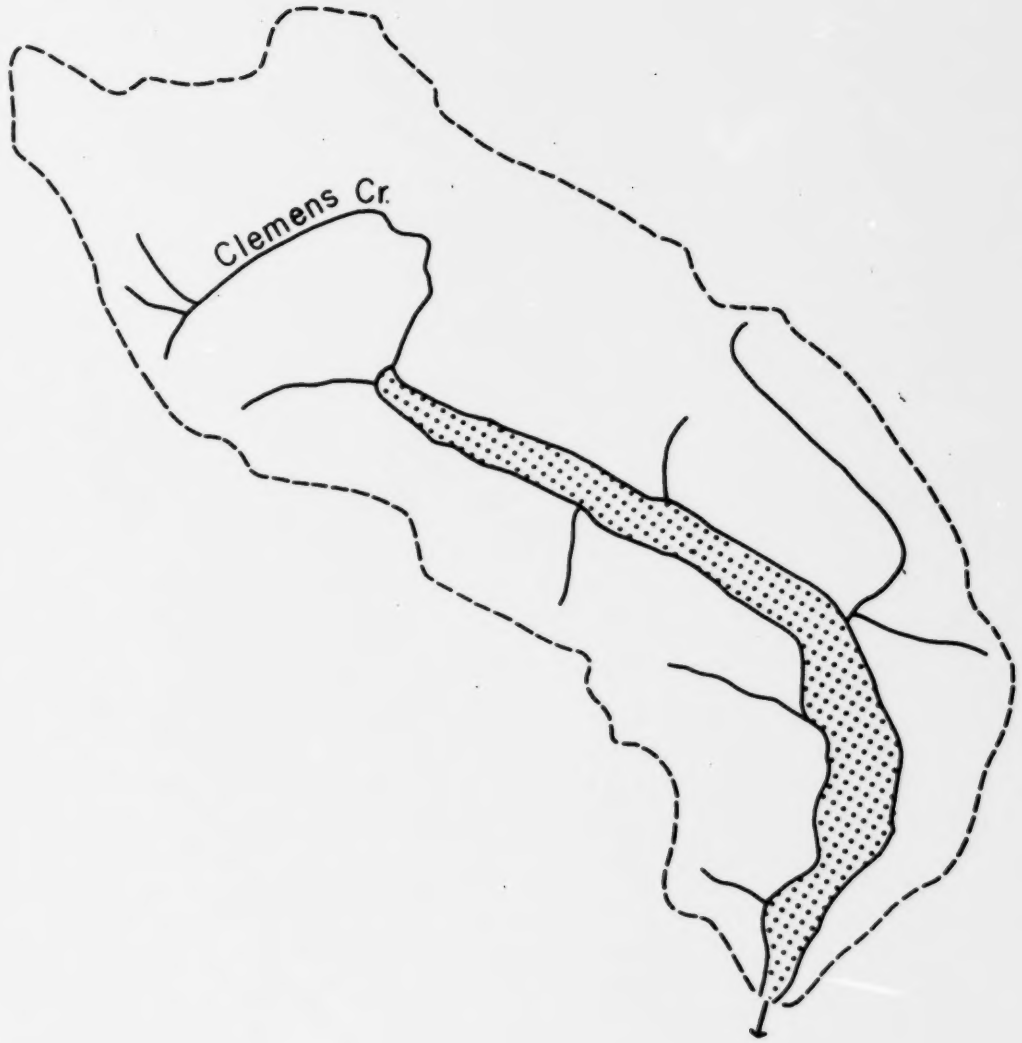
GREAT CENTRAL LAKE

CONTOUR LINES IN METRES

0 5 10 Km

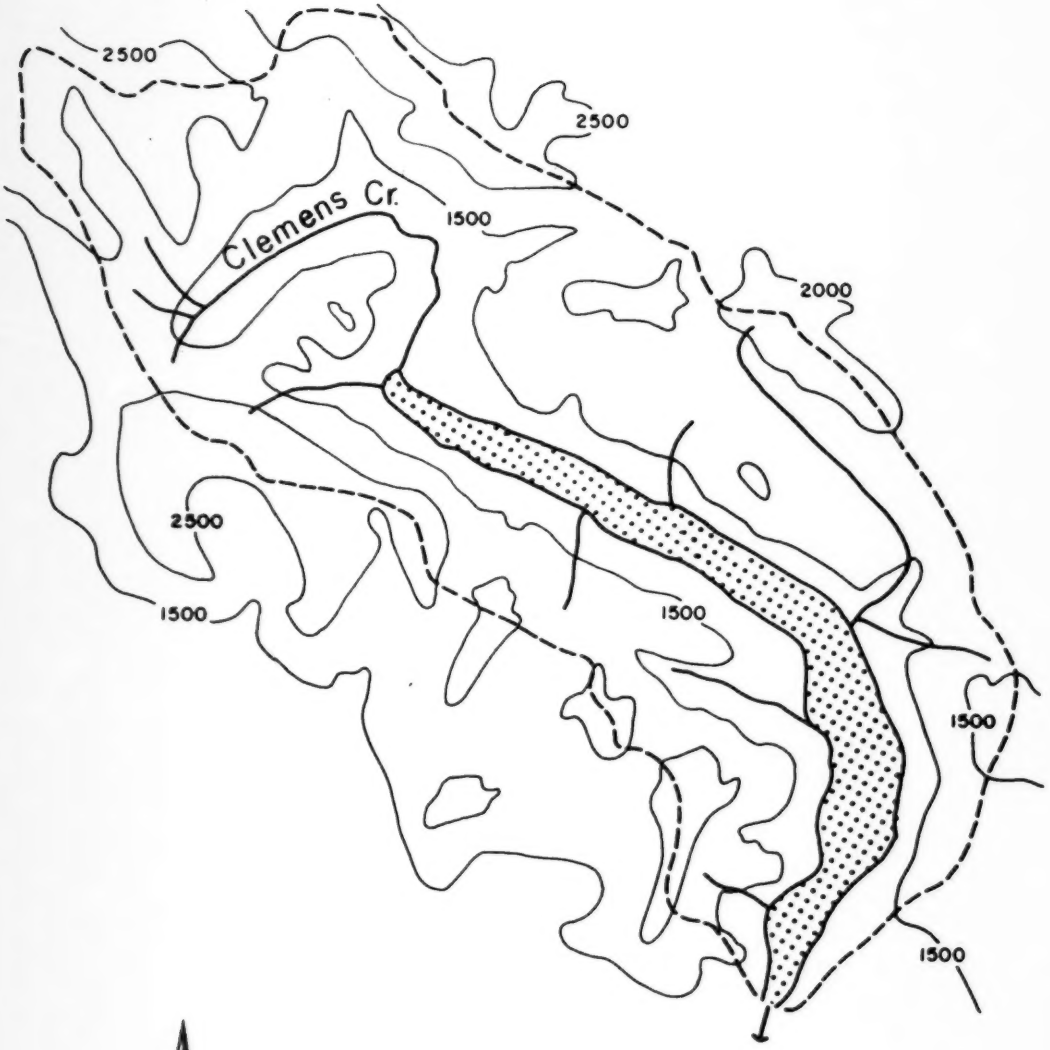

N
50
100
150
200
250
200
150
250
BOOT
LAGOON
STAMP
RIVER
GREAT CENTRAL LAKE
DEPTH CONTOURS IN METRES
0
4Km

N
1
2
3
4
5
6
GREAT CENTRAL LAKE
BOOT
LAGOON
STAMP
RIVER
0
4Km



HENDERSON LAKE

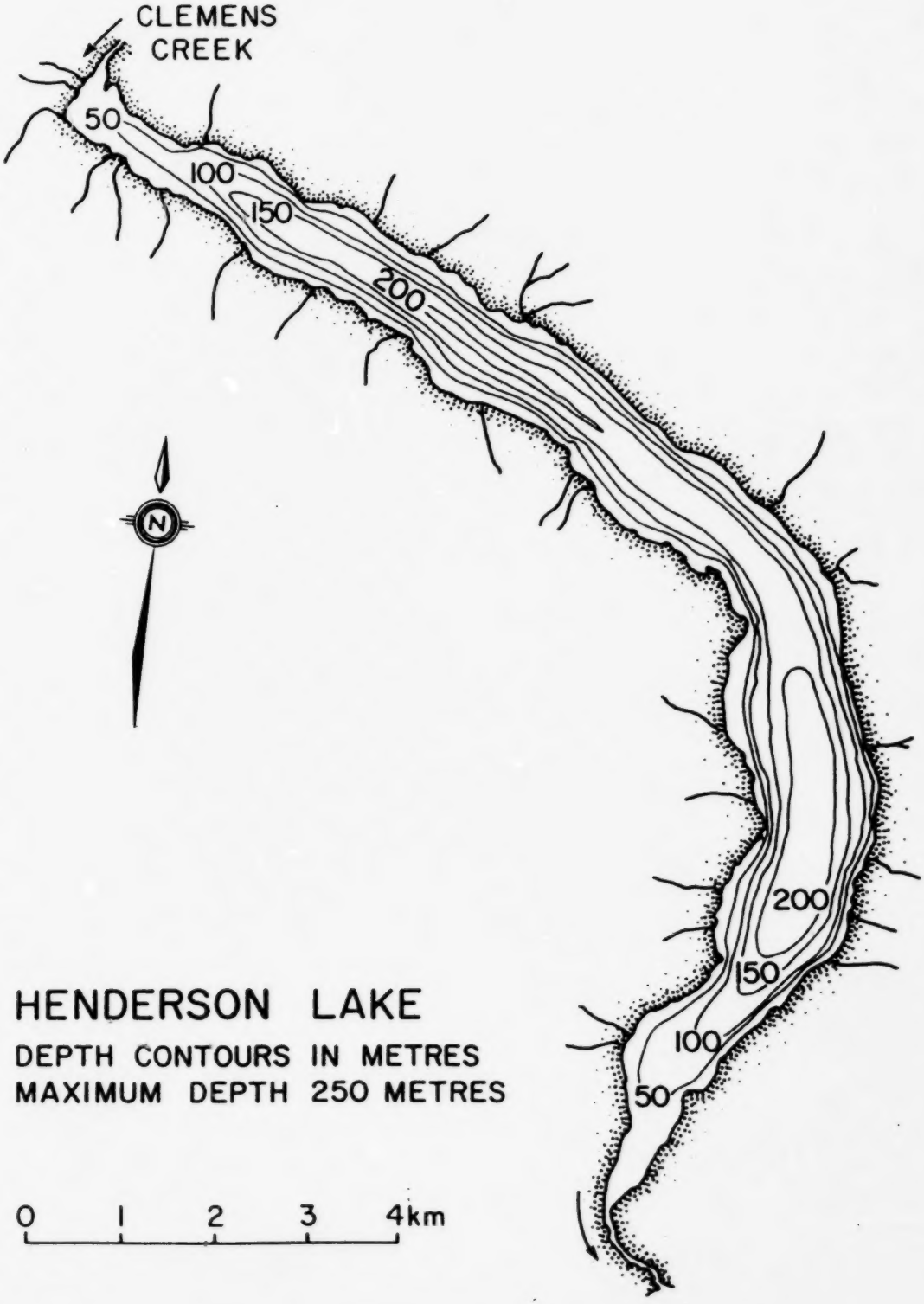
0 1 2 3 4 5Km

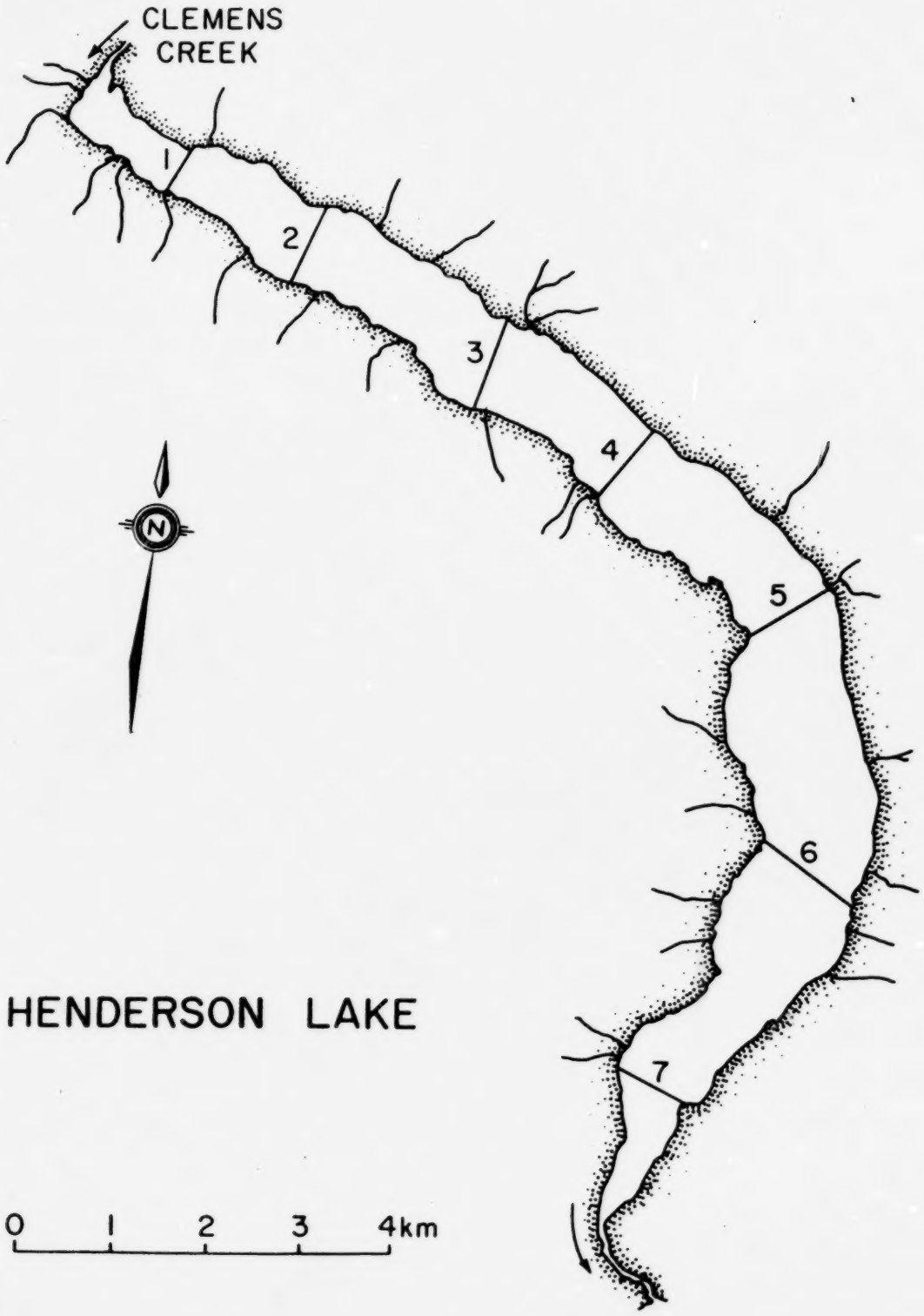


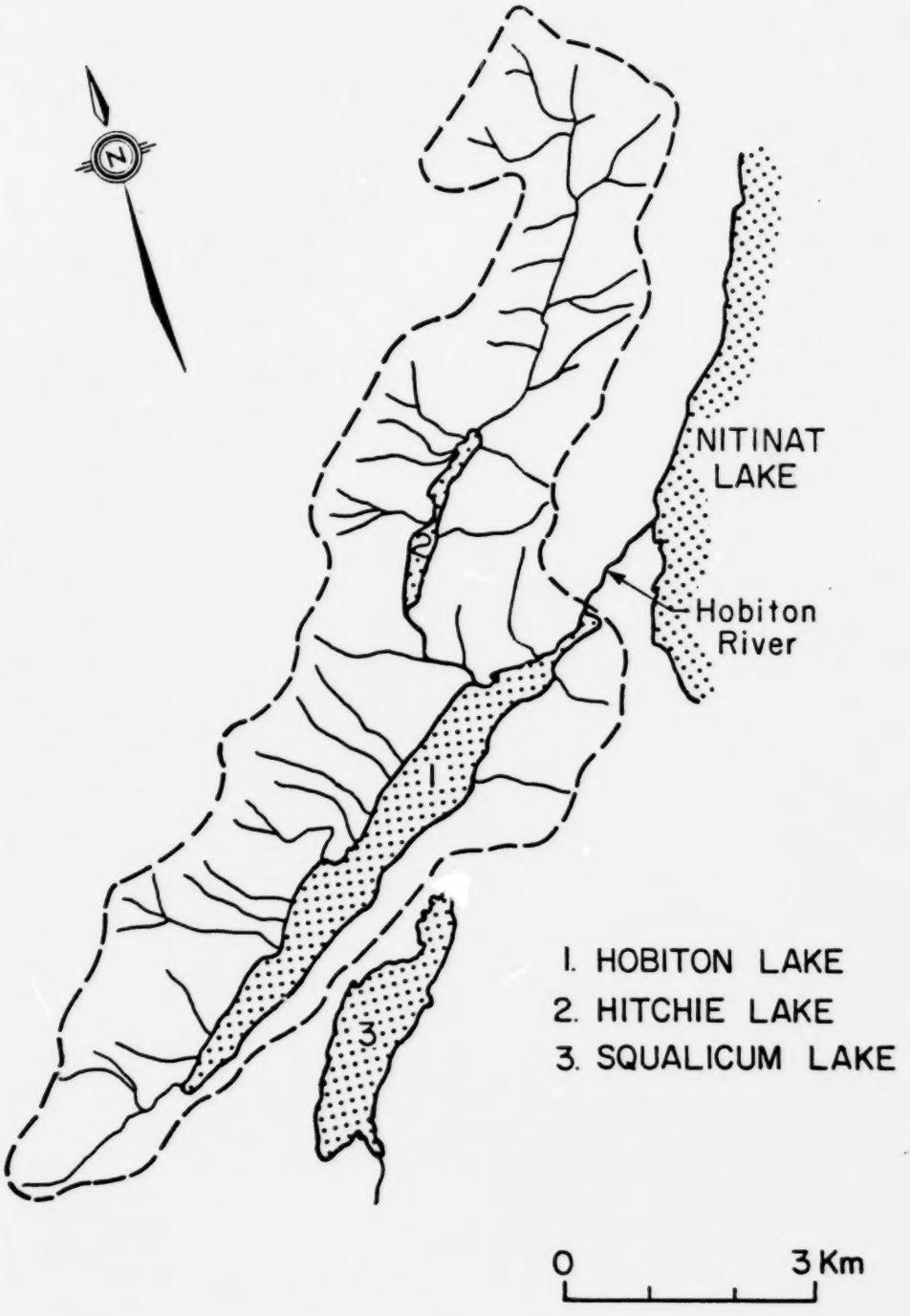
HENDERSON LAKE

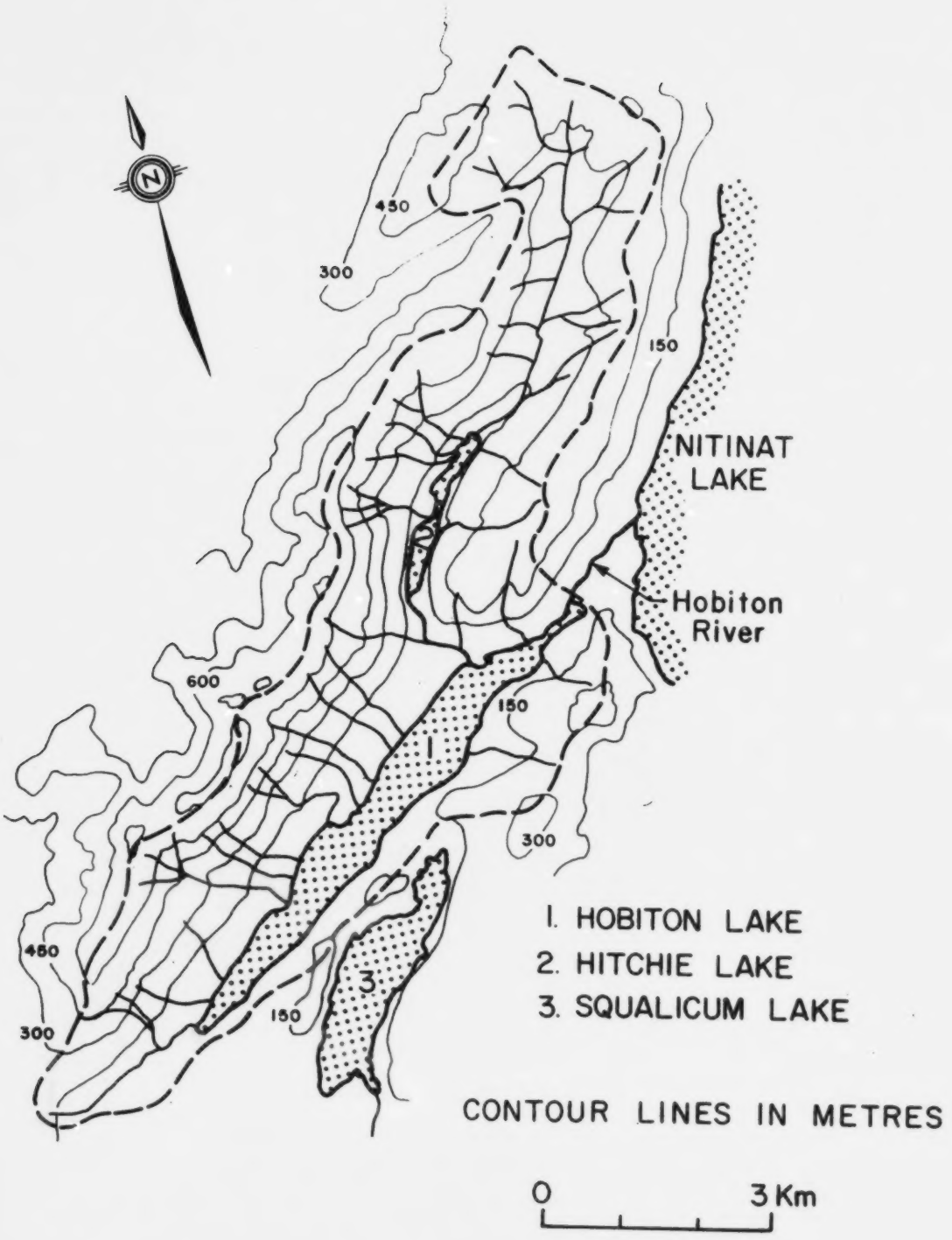
CONTOUR LINES IN METRES

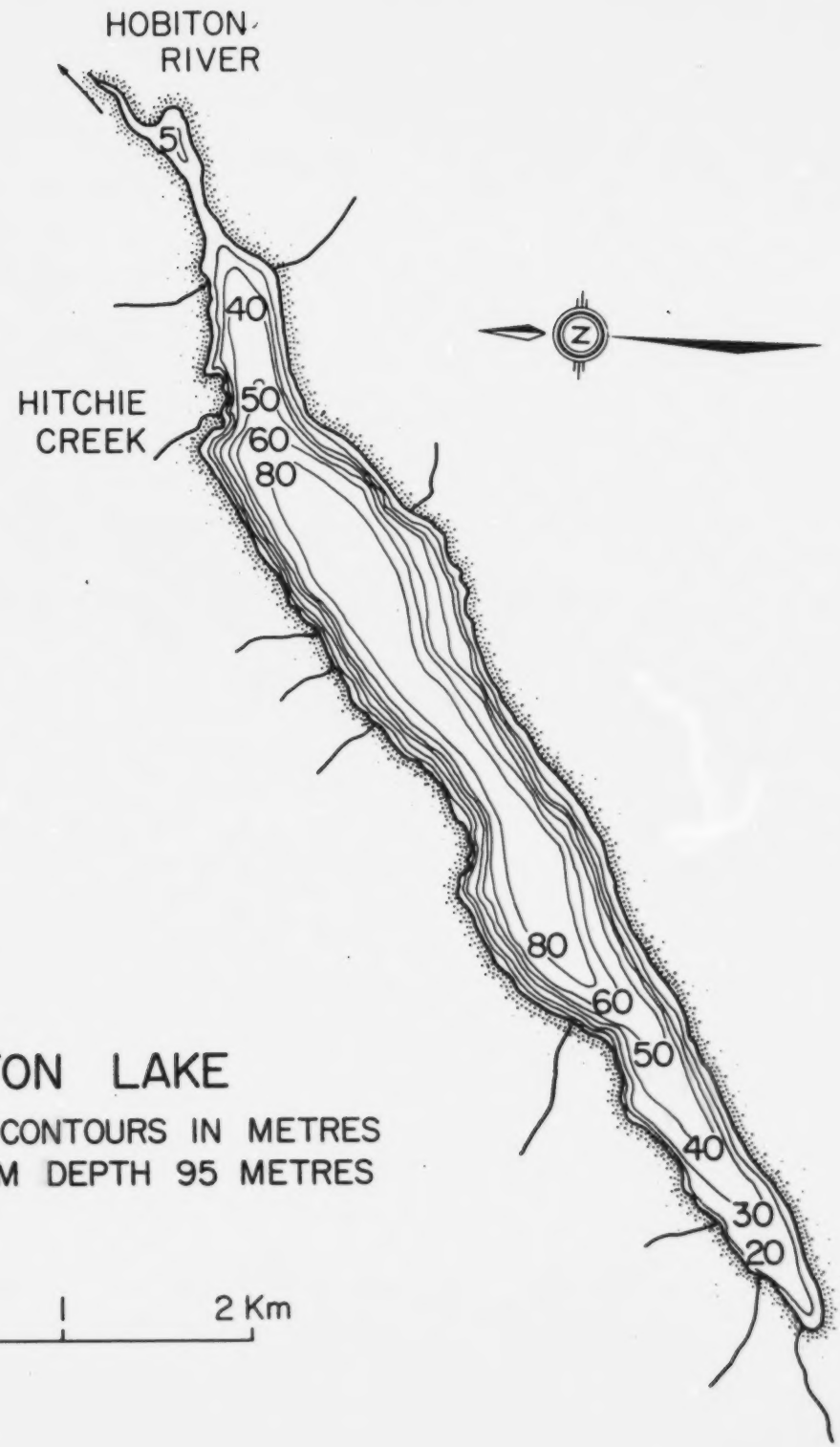
0 1 2 3 4 5 Km

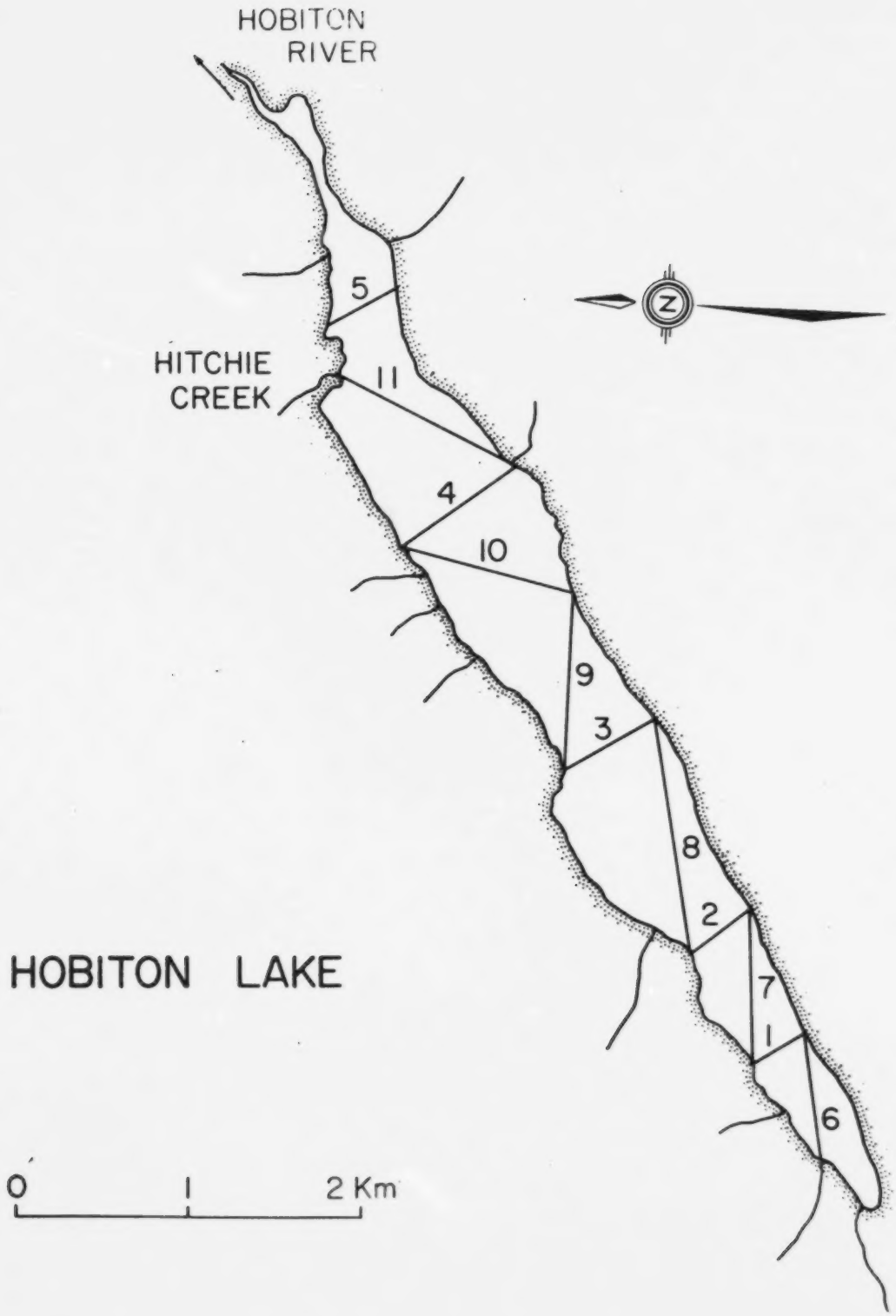

CLEMENS
CREEK
50
100
150
200
N
200
150
100
50
HENDERSON LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 250 METRES
0 1 2 3 4km

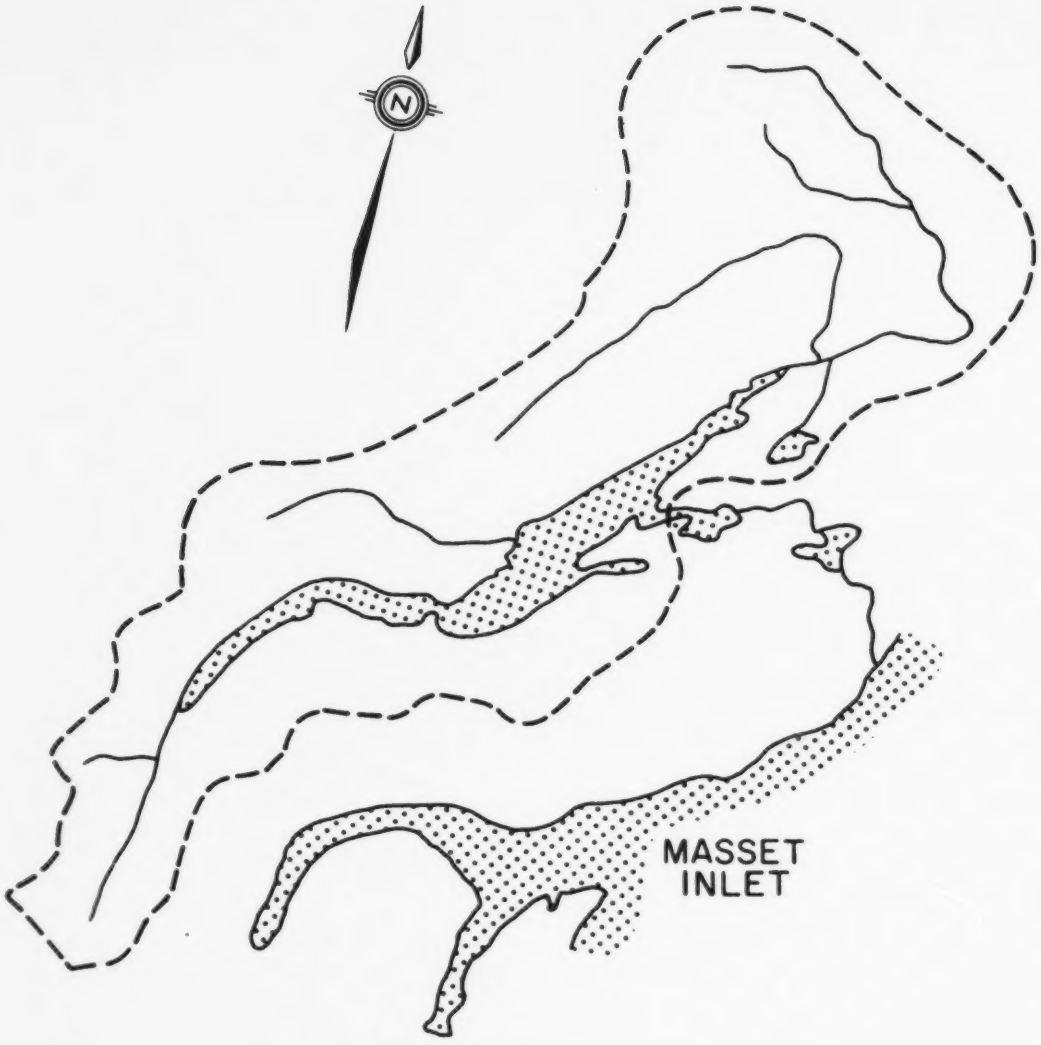

CLEMENS
CREEK
1
2
3
4
5
6
7
N
HENDERSON LAKE
0 1 2 3 4km


N
NITINAT
LAKE
Hobiton
River
1
2
3
1. HOBITON LAKE
2. HITCHIE LAKE
3. SQUALICUM LAKE
0
3 Km


N
450
300
150
NITINAT
LAKE
Hobiton
River
600
150
300
450
300
150
1
3
1. HOBITON LAKE
2. HITCHIE LAKE
3. SQUALICUM LAKE
CONTOUR LINES IN METRES
0
3 Km

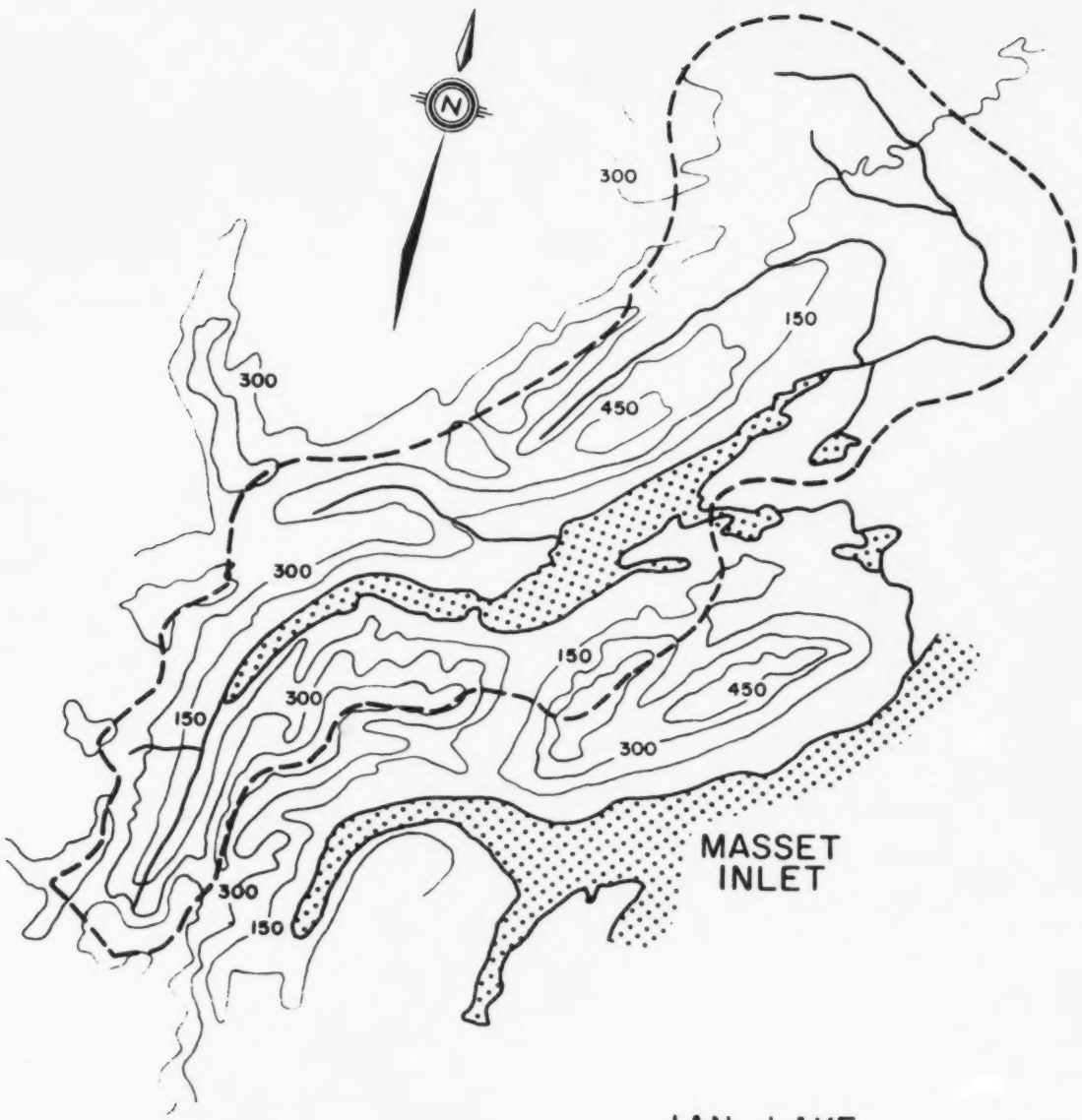

HOBITON RIVER
5
40
50
60
80
HITCHIE CREEK
N
80
60
50
40
30
20
HOBITON LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 95 METRES
0
1
2 Km


HOBITON
RIVER
HITCHIE
CREEK
5
11
4
10
9
3
8
2
7
1
6
N
HOBITON LAKE
0
1
2 Km



IAN LAKE

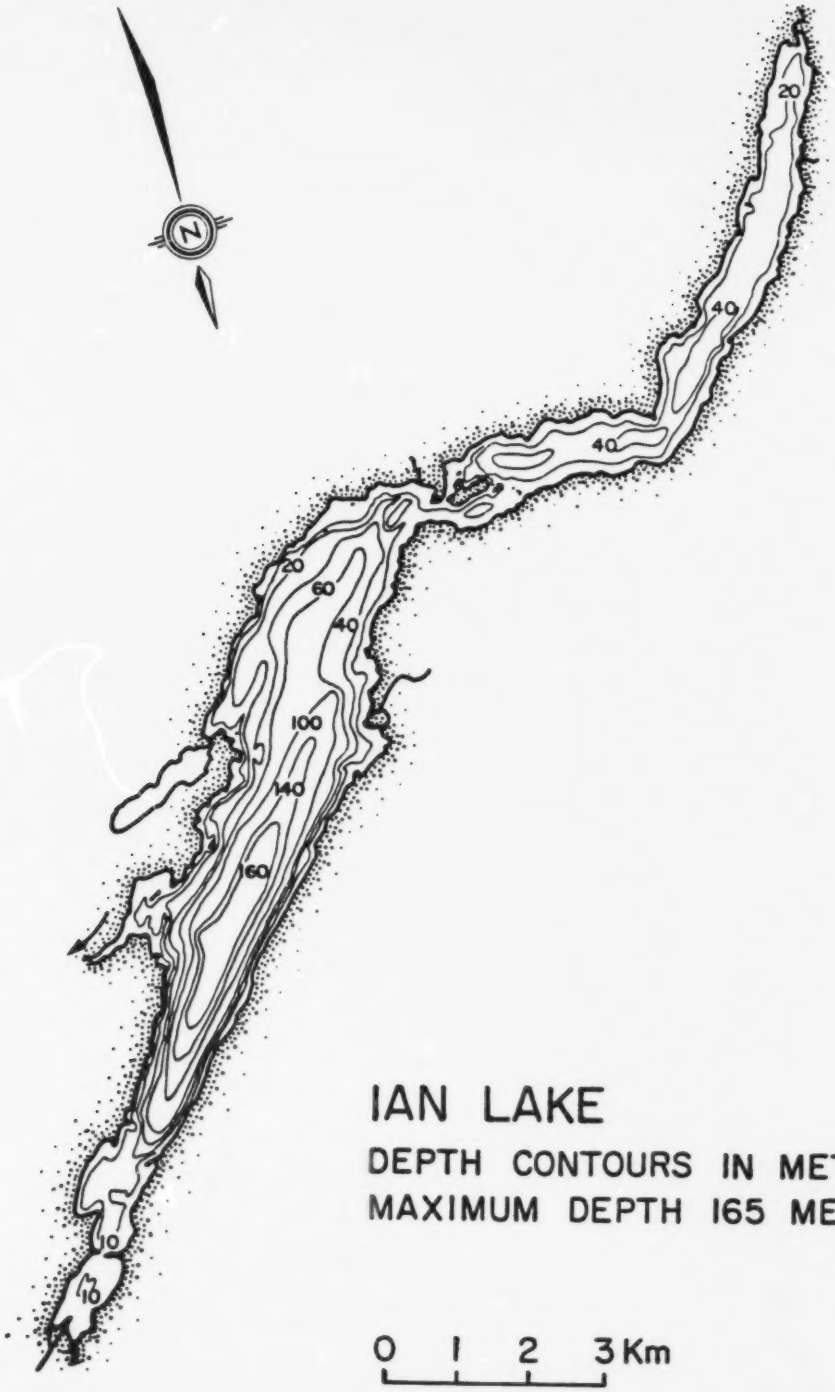
0 10 Km

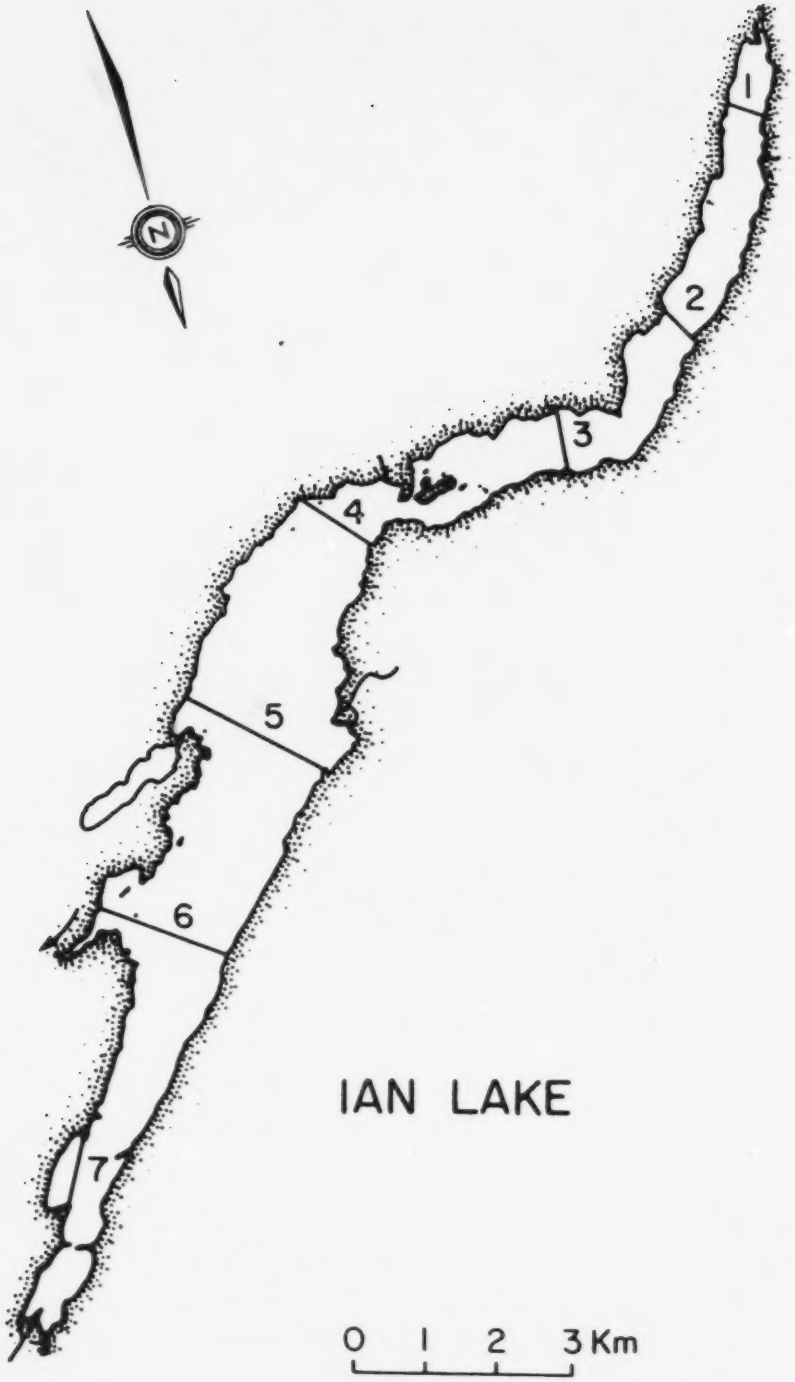


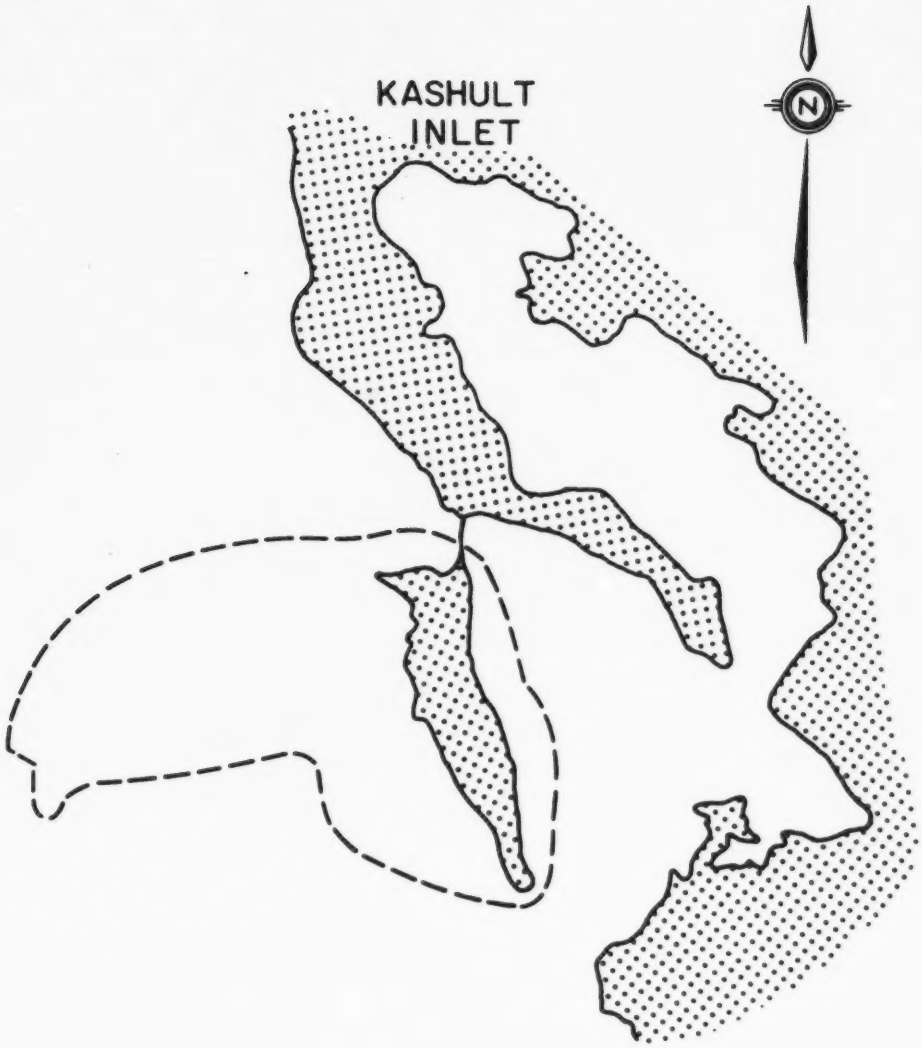
IAN LAKE

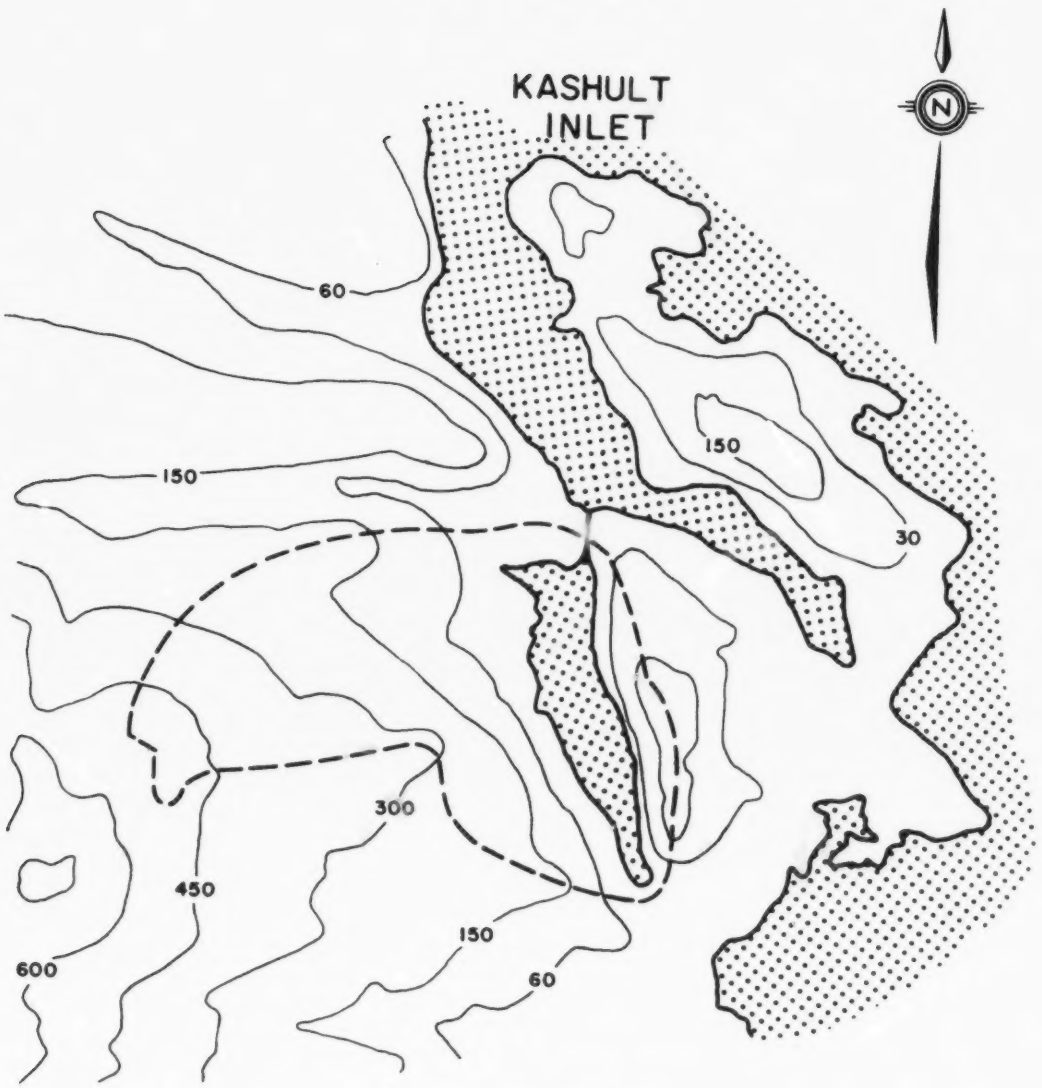
CONTOUR LINES IN METRES

0 10 Km


N
20
40
40
20
60
40
100
140
160
10
10
IAN LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 165 METRES
0 1 2 3 Km


N
1
2
3
4
5
6
7
IAN LAKE
0 1 2 3 Km

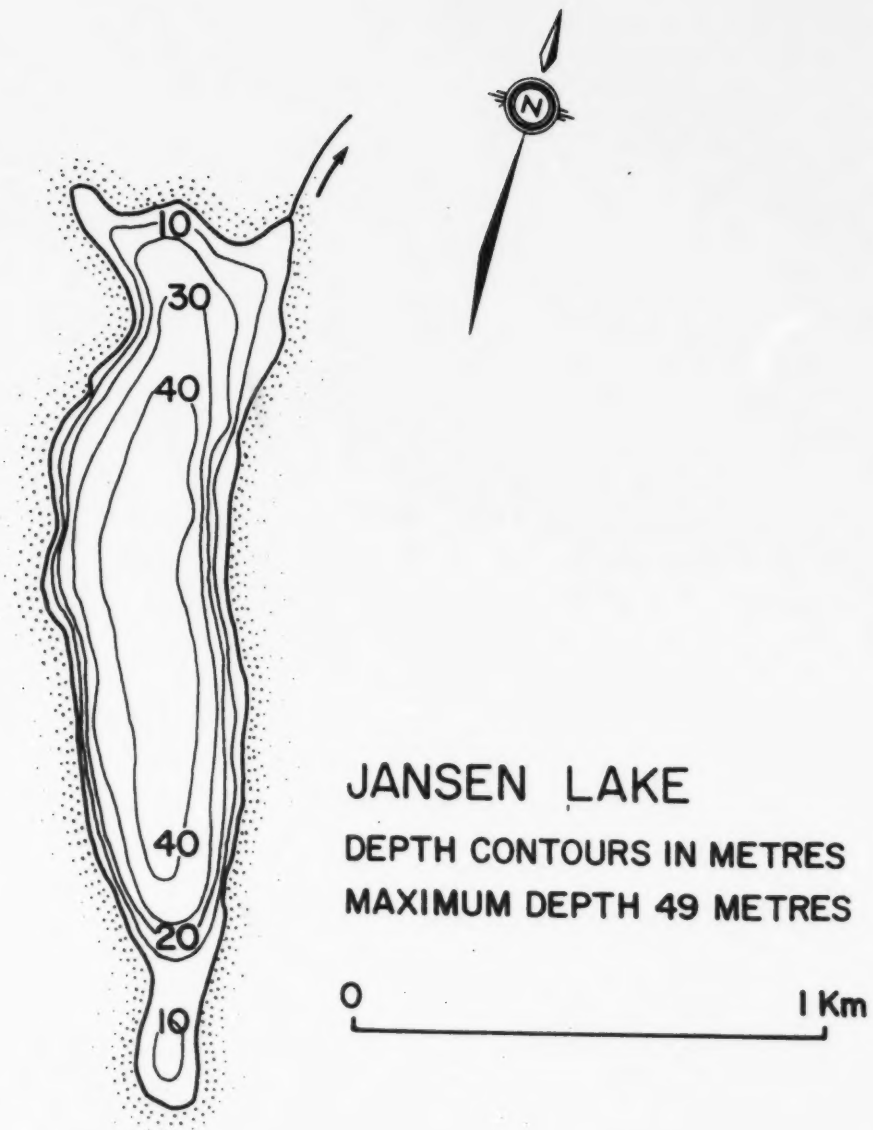

KASHULT
INLET
N
JANSEN LAKE
0
3 Km

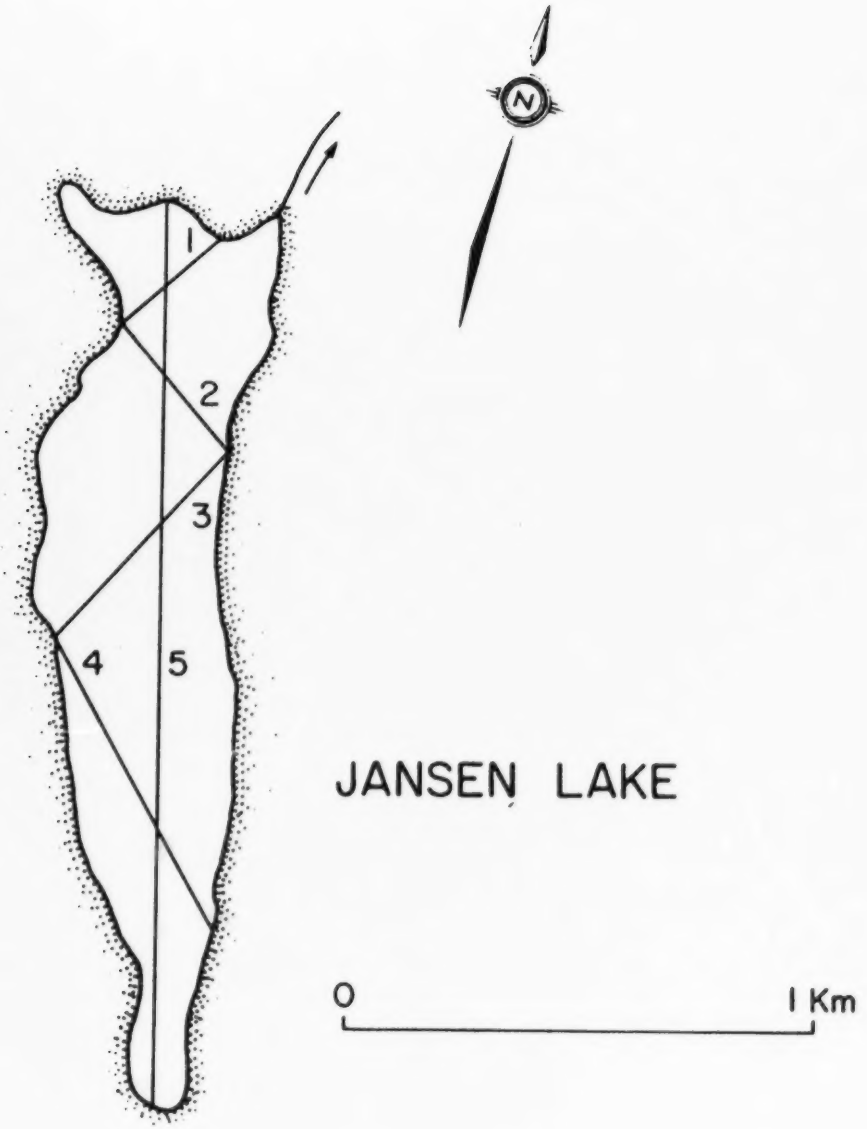


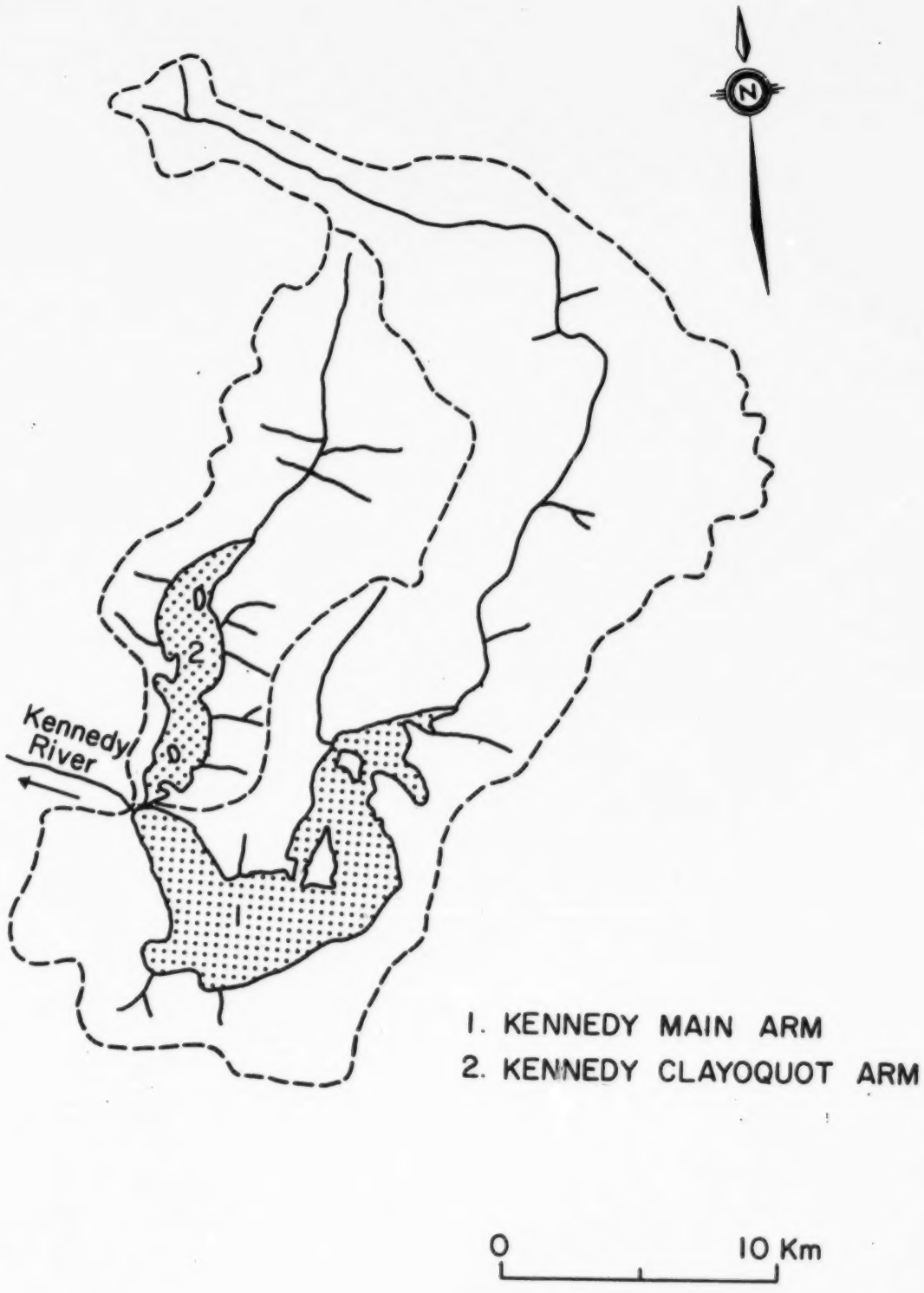
JANSEN LAKE

CONTOUR LINES IN METRES

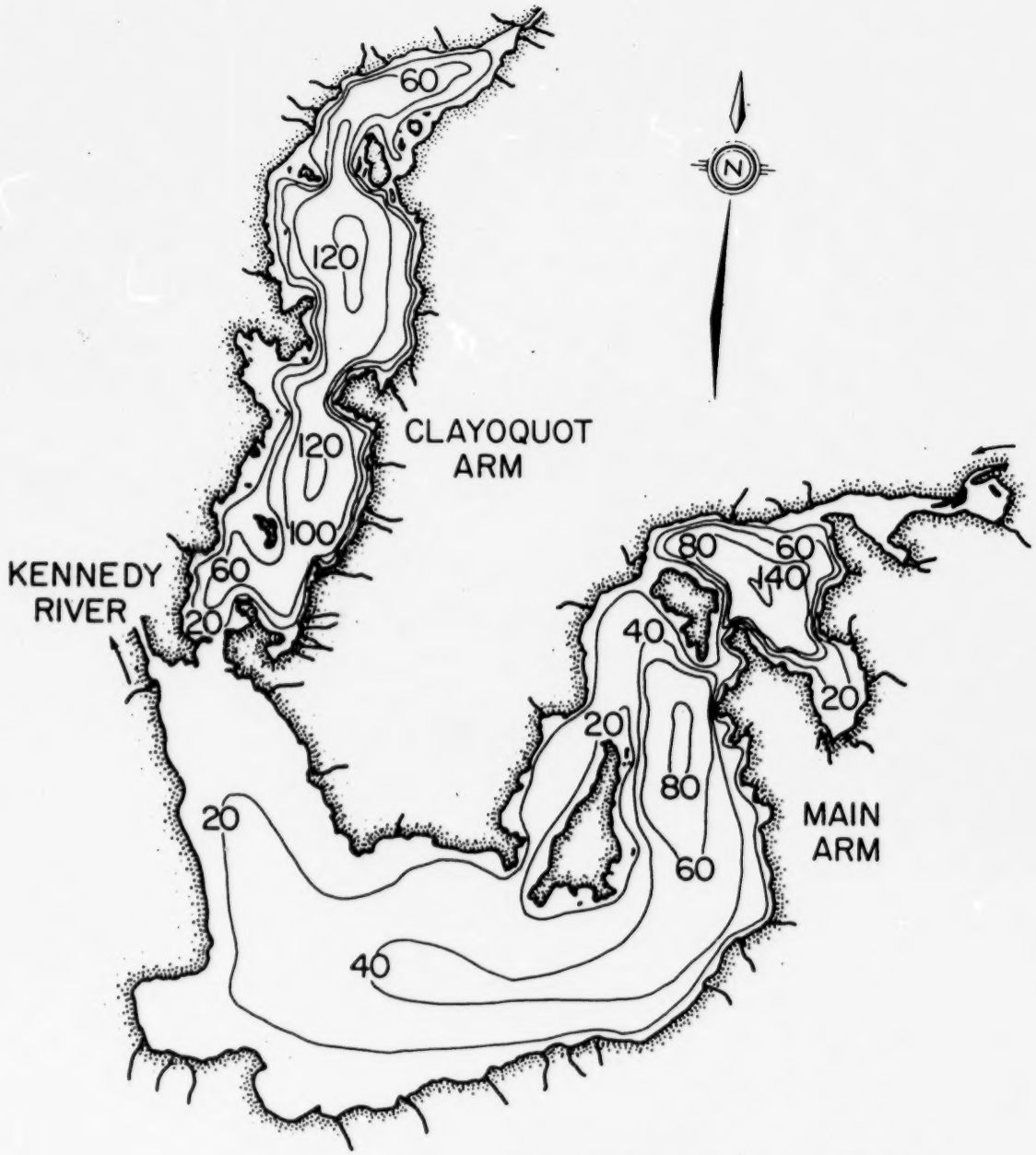
0 3 Km


N
10
30
40
40
20
10
JANSEN LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 49 METRES
0
1 Km


N
1
2
3
4
5
JANSEN LAKE
0
1 Km


N
Kennedy River
1. KENNEDY MAIN ARM
2. KENNEDY CLAYOQUOT ARM
0
10 Km

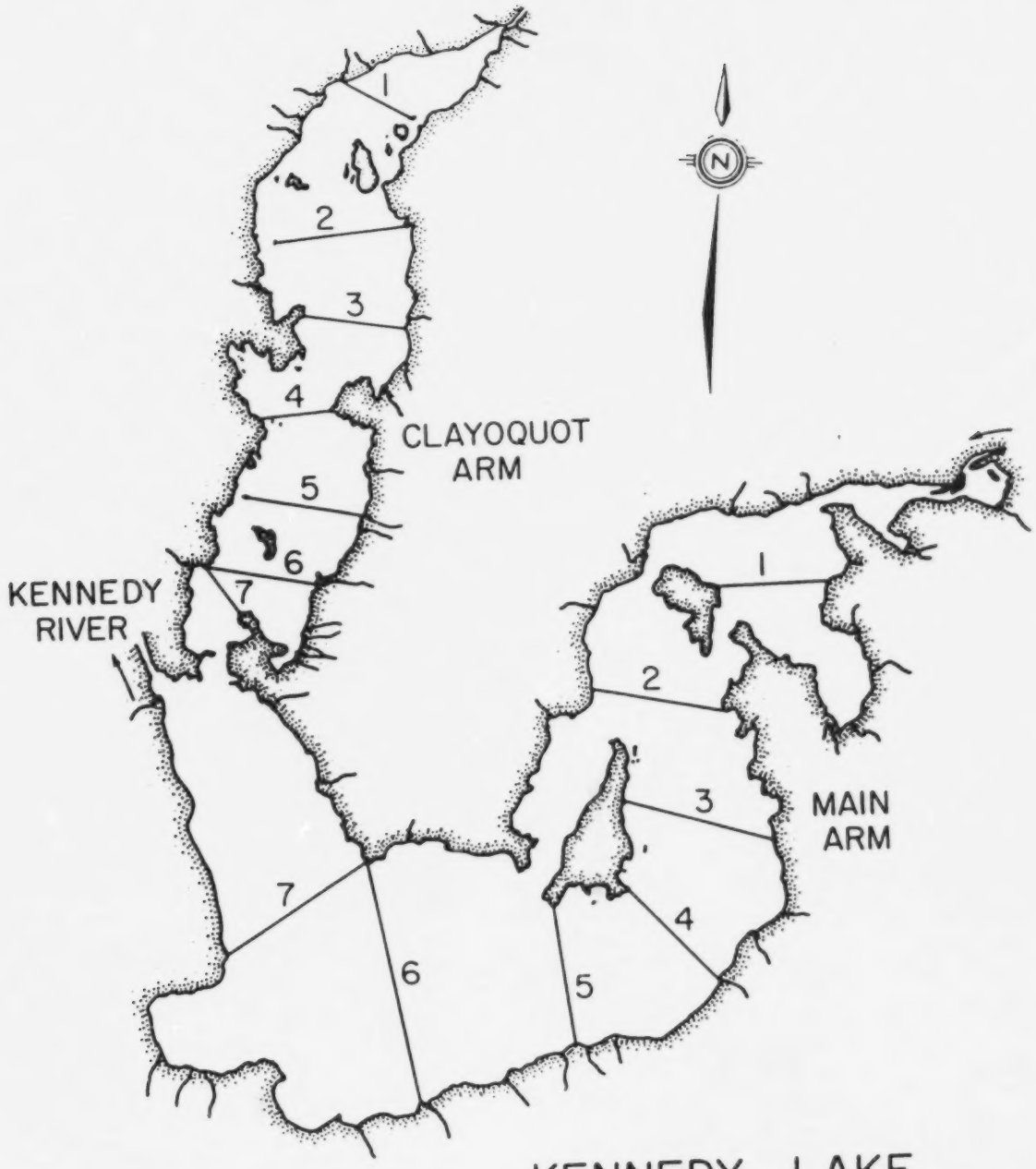
N
760
300
760
300
760
760
300
Kennedy River
0
2
0
1
300
1. KENNEDY MAIN ARM
2. KENNEDY CLAYOQUOT ARM
CONTOUR LINES IN METRES
0
10 Km

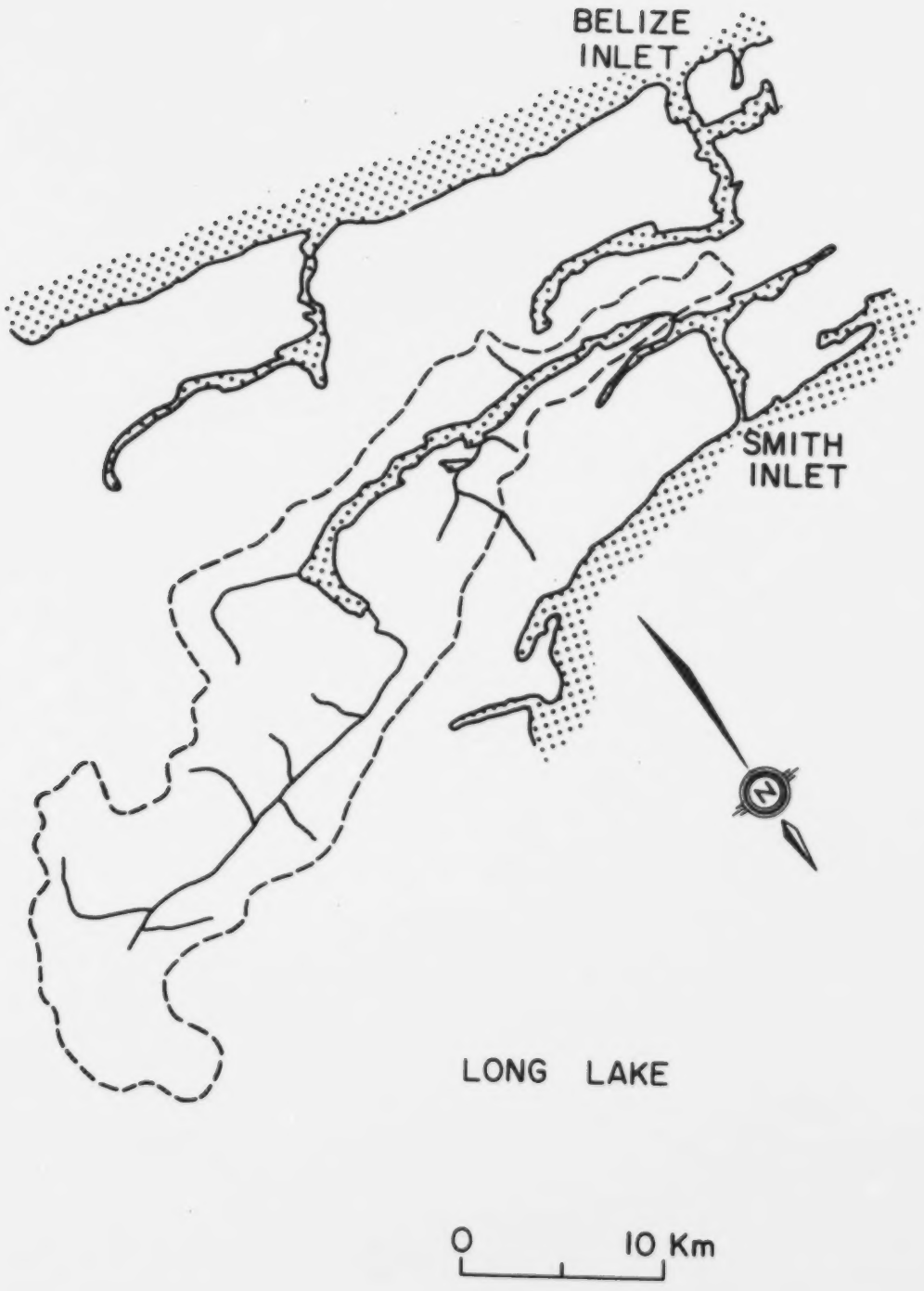


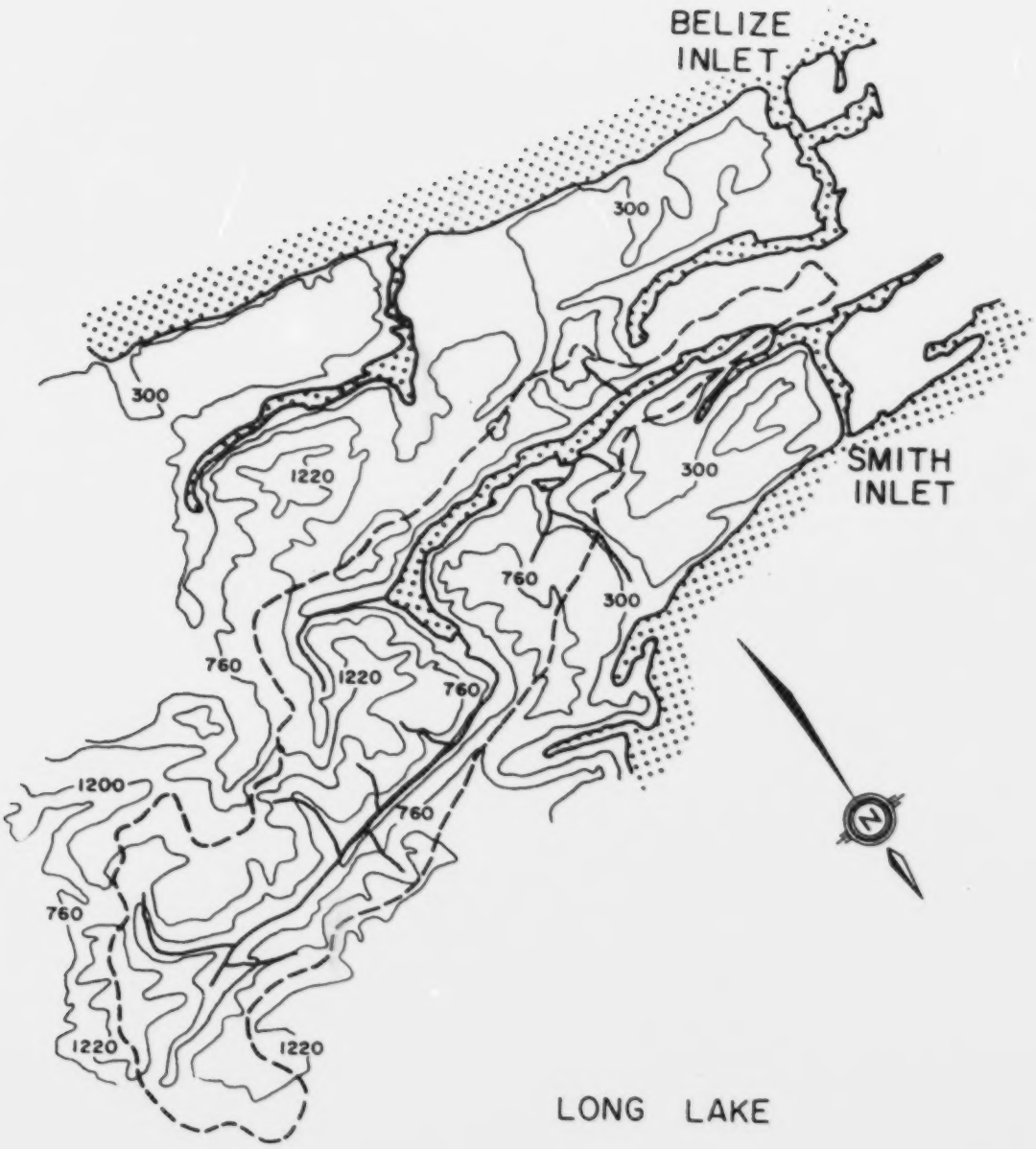
KENNEDY LAKE

DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 145 METRES

0 1 2 3 4 Km


1
2
3
4
5
6
7
CLAYOQUOT
ARM
KENNEDY
RIVER
N
1
2
3
4
5
6
7
MAIN
ARM
KENNEDY LAKE
0 1 2 3 4 Km

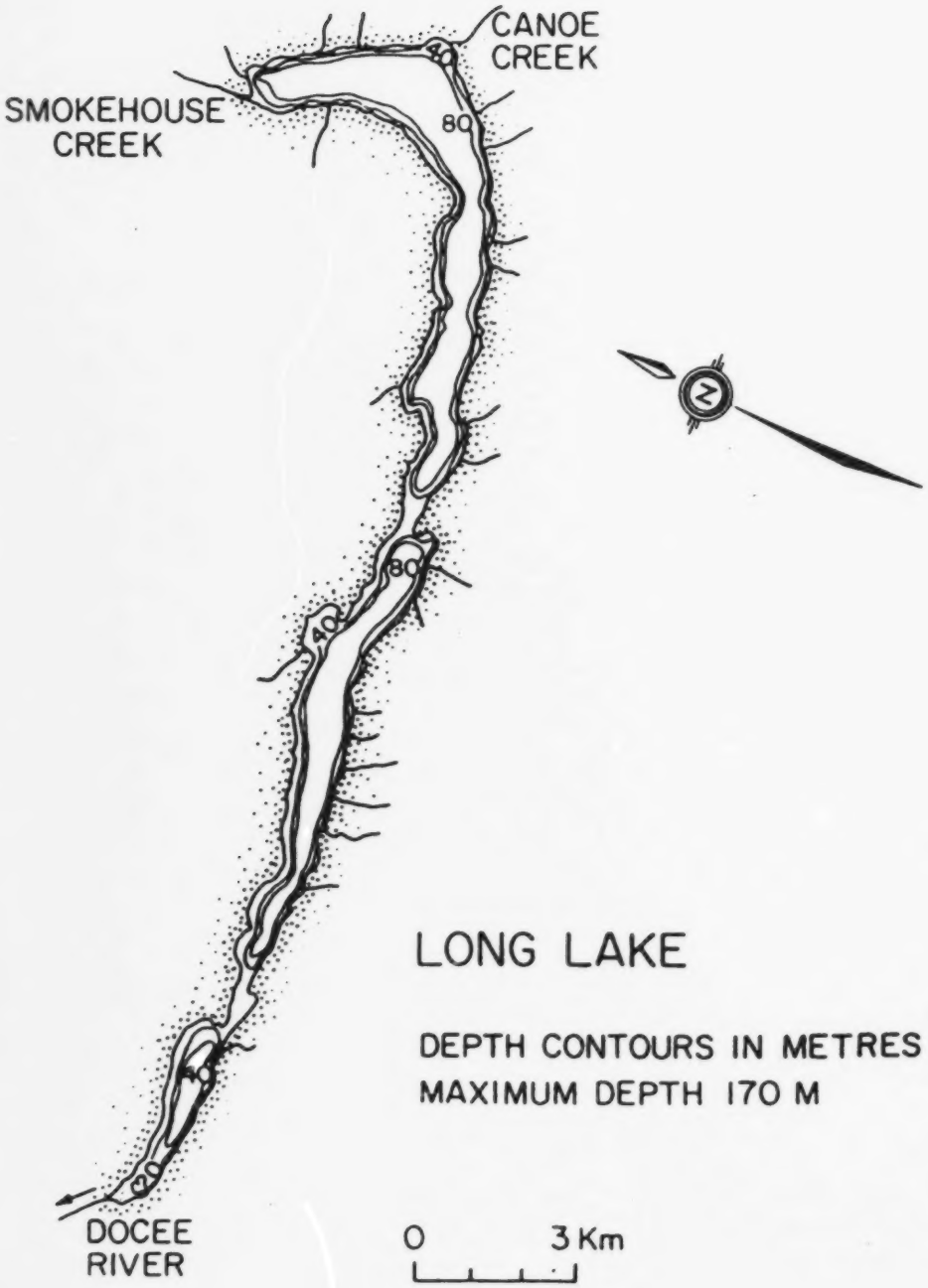

BELIZE
INLET
SMITH
INLET
N
LONG LAKE
0
10 Km

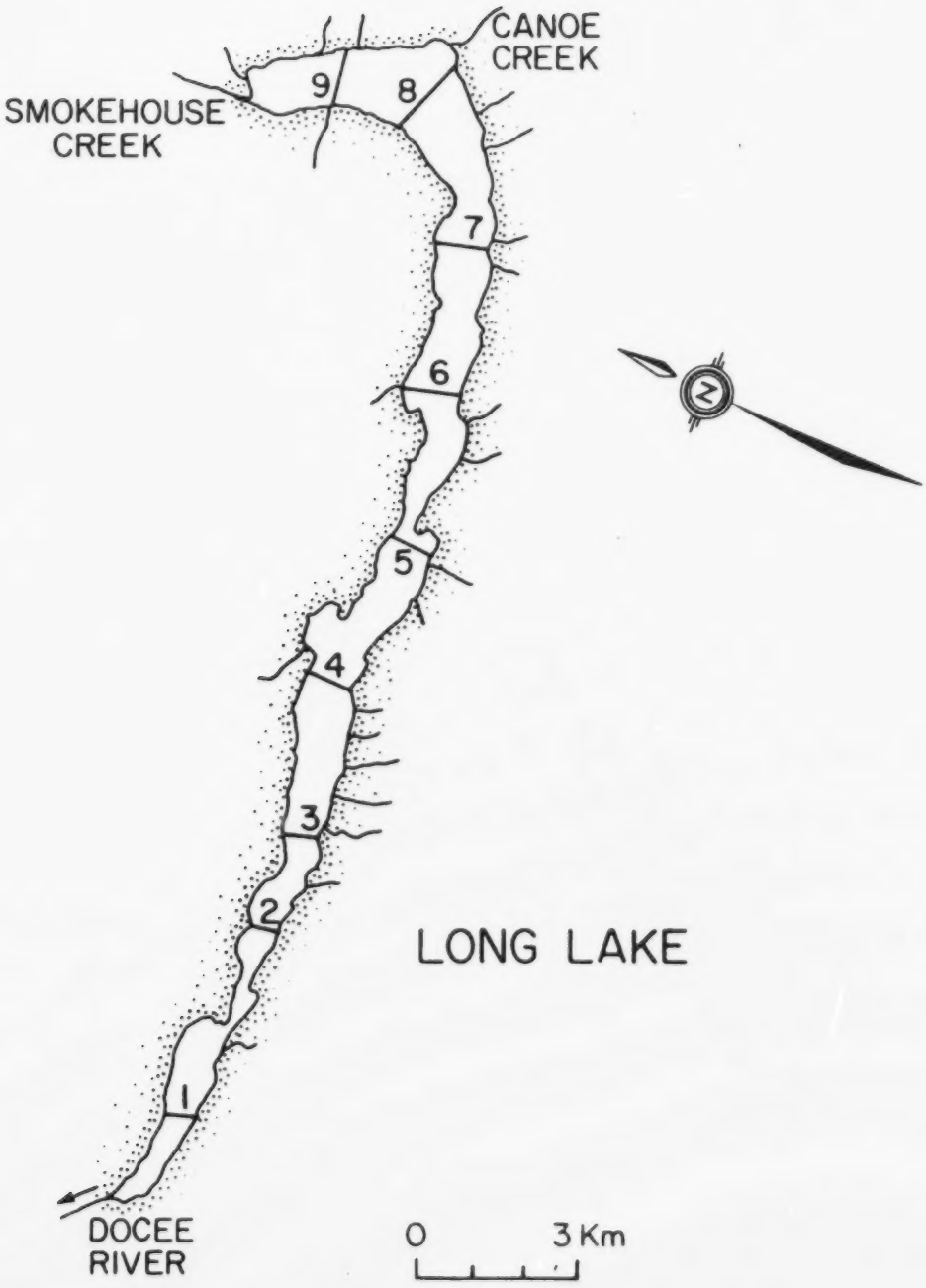


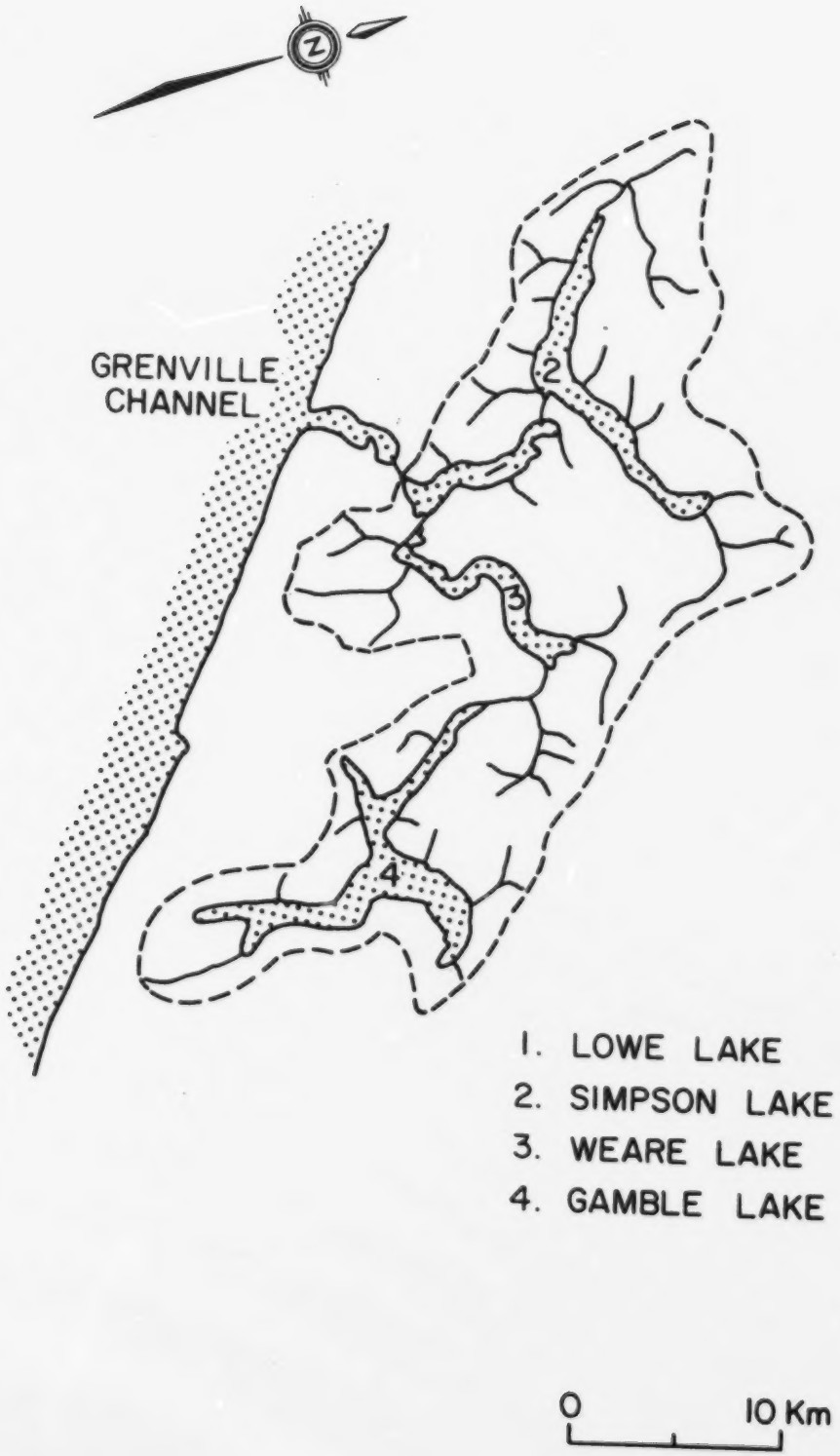
LONG LAKE

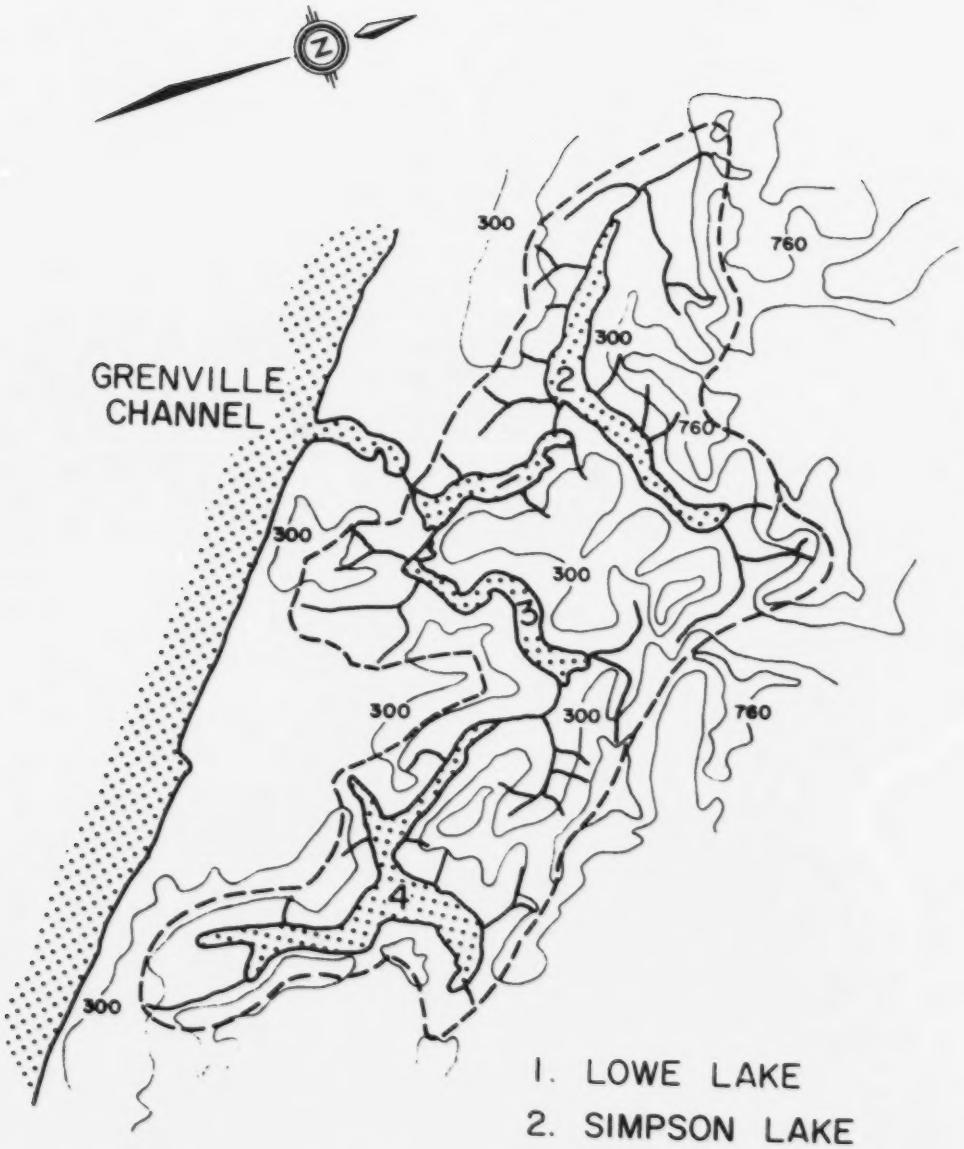
CONTOUR LINES IN METRES

0 10 Km


CANOE
CREEK
SMOKEHOUSE
CREEK
80
80
40
40
20
DOCEE
RIVER
N
LONG LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 170 M
0
3 Km


CANOE
CREEK
SMOKEHOUSE
CREEK
9
8
7
6
5
4
3
2
1
N
LONG LAKE
DOCEE
RIVER
0
3 Km

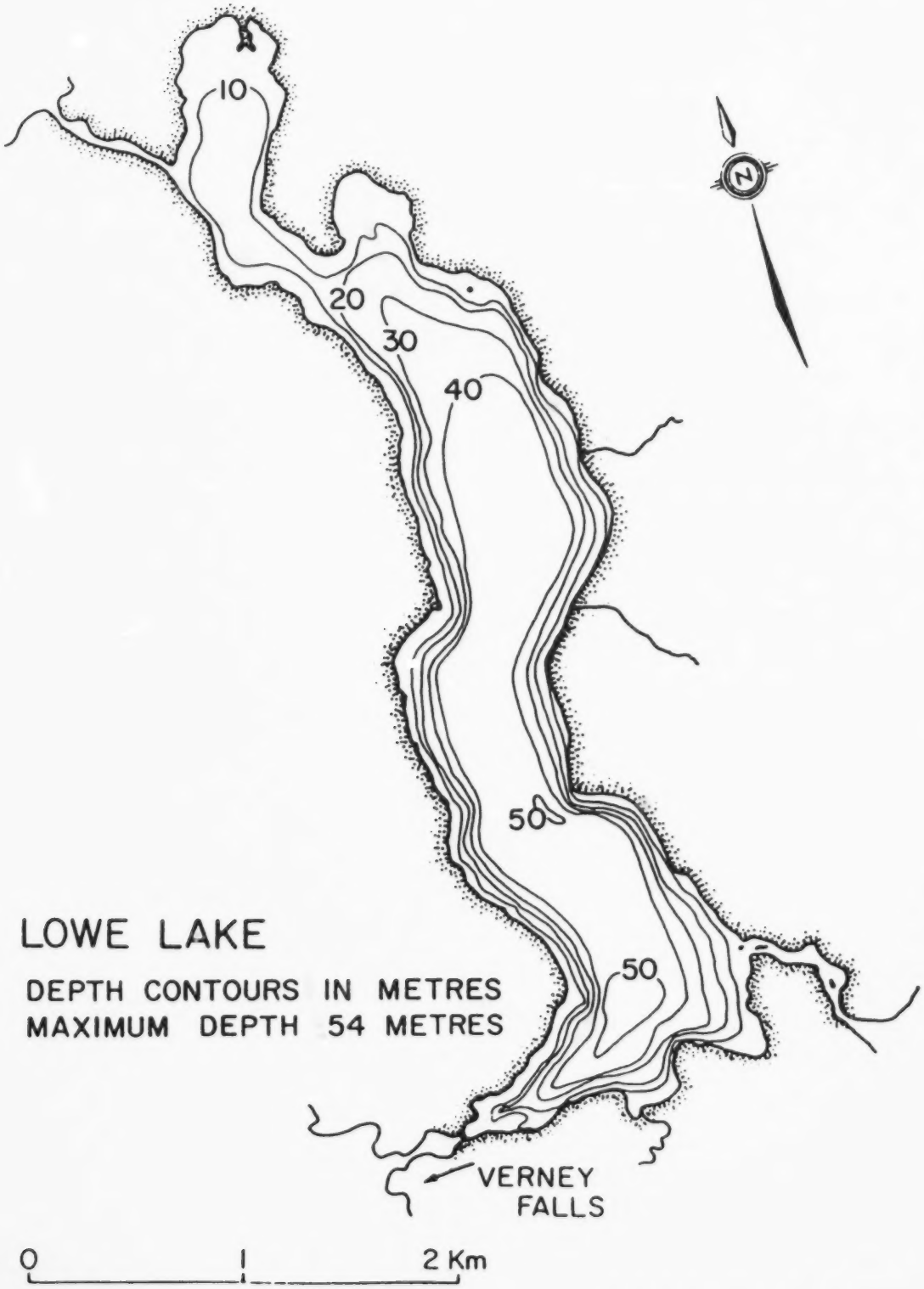

N
GRENVILLE
CHANNEL
2
3
4
1. LOWE LAKE
2. SIMPSON LAKE
3. WEARE LAKE
4. GAMBLE LAKE
0
10 Km

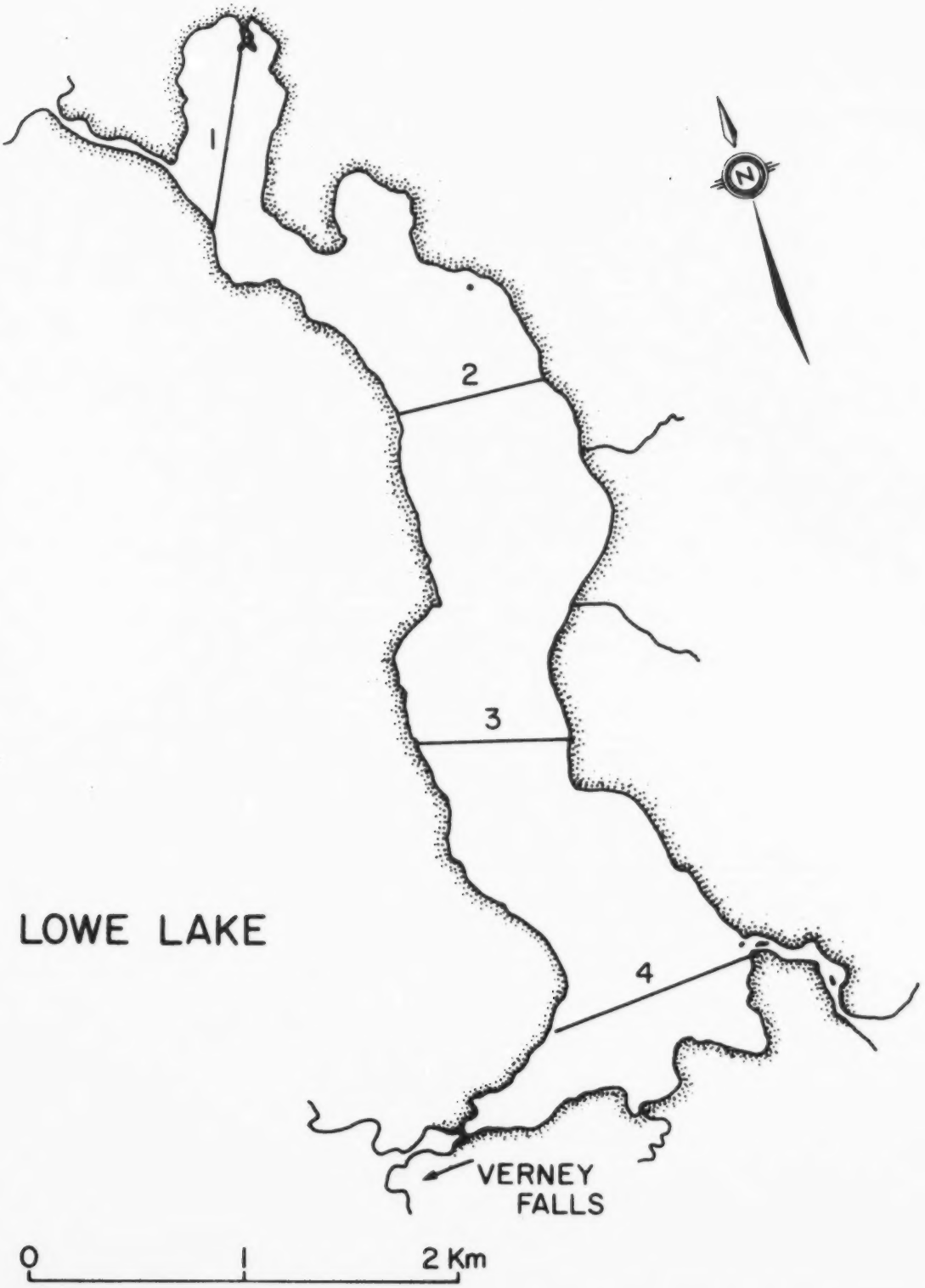


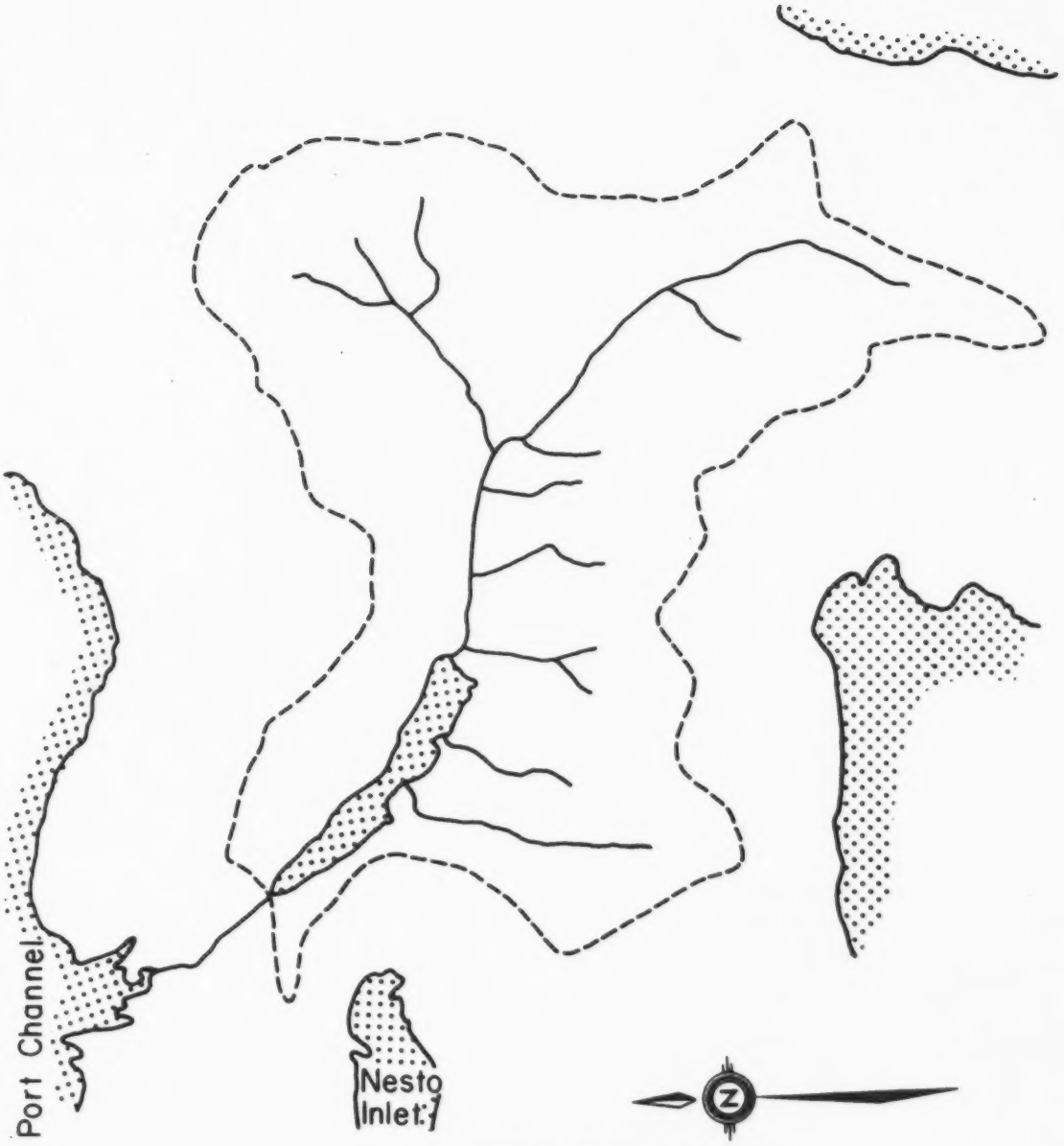
1. LOWE LAKE
2. SIMPSON LAKE
3. WEARE LAKE
4. GAMBLE LAKE

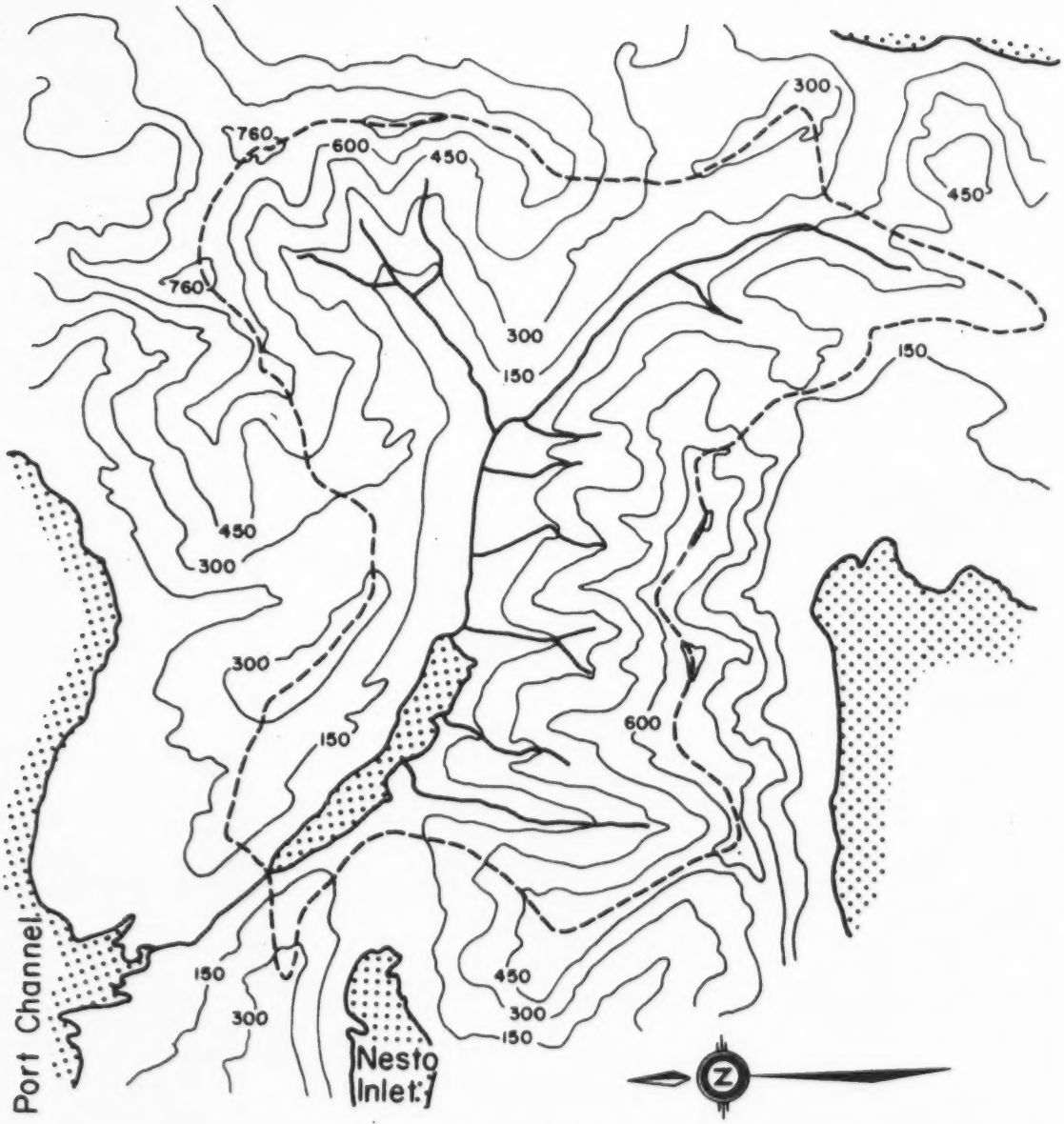
CONTOUR LINES IN METRES

0 10 Km


10
20
30
40
50
50
N
LOWE LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 54 METRES
VERNEY
FALLS
0
1
2 Km


1
2
3
4
N
LOWE LAKE
VERNEY
FALLS
0
1
2 Km

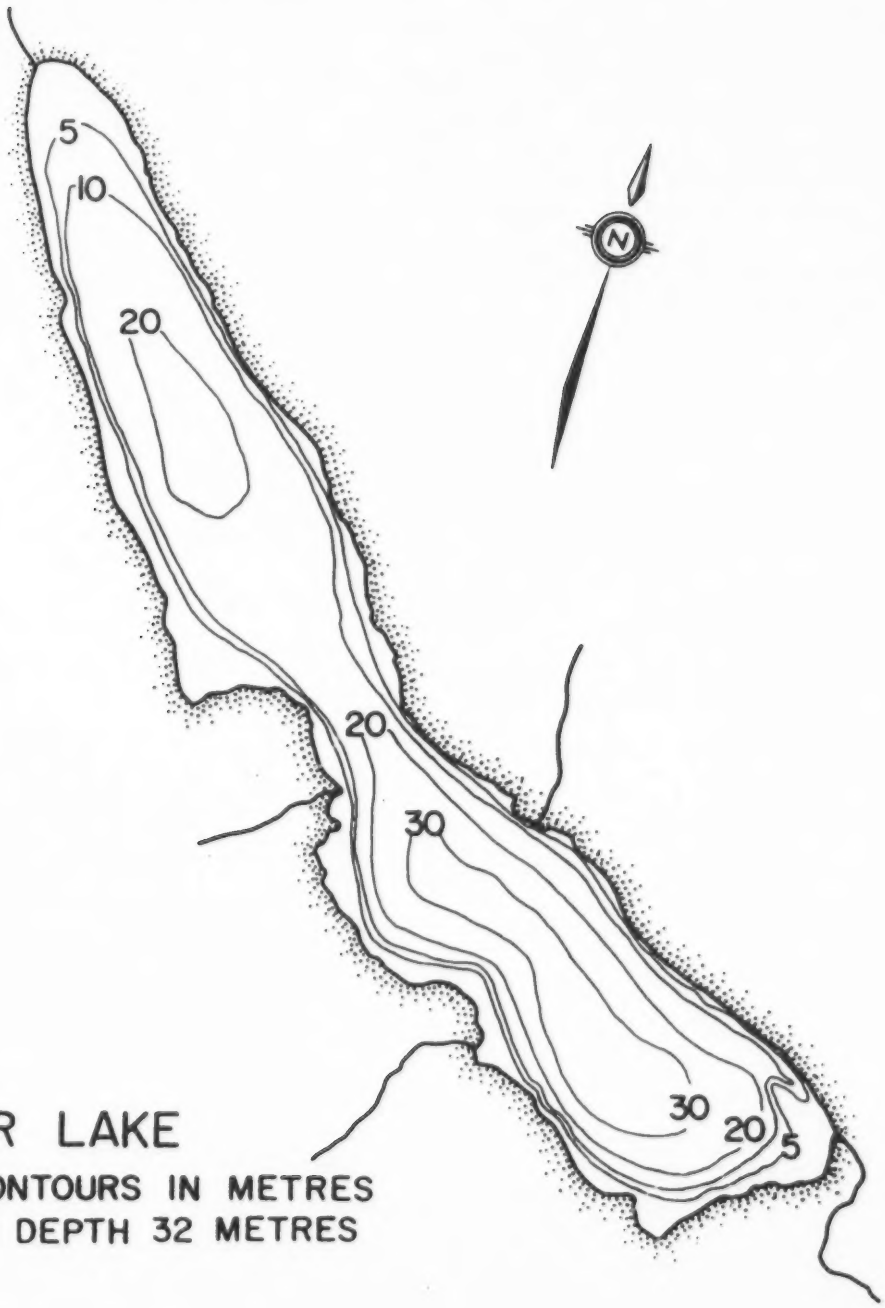

Port Channel
Nesto Inlet
N
MERCER LAKE
0
1
2 Km

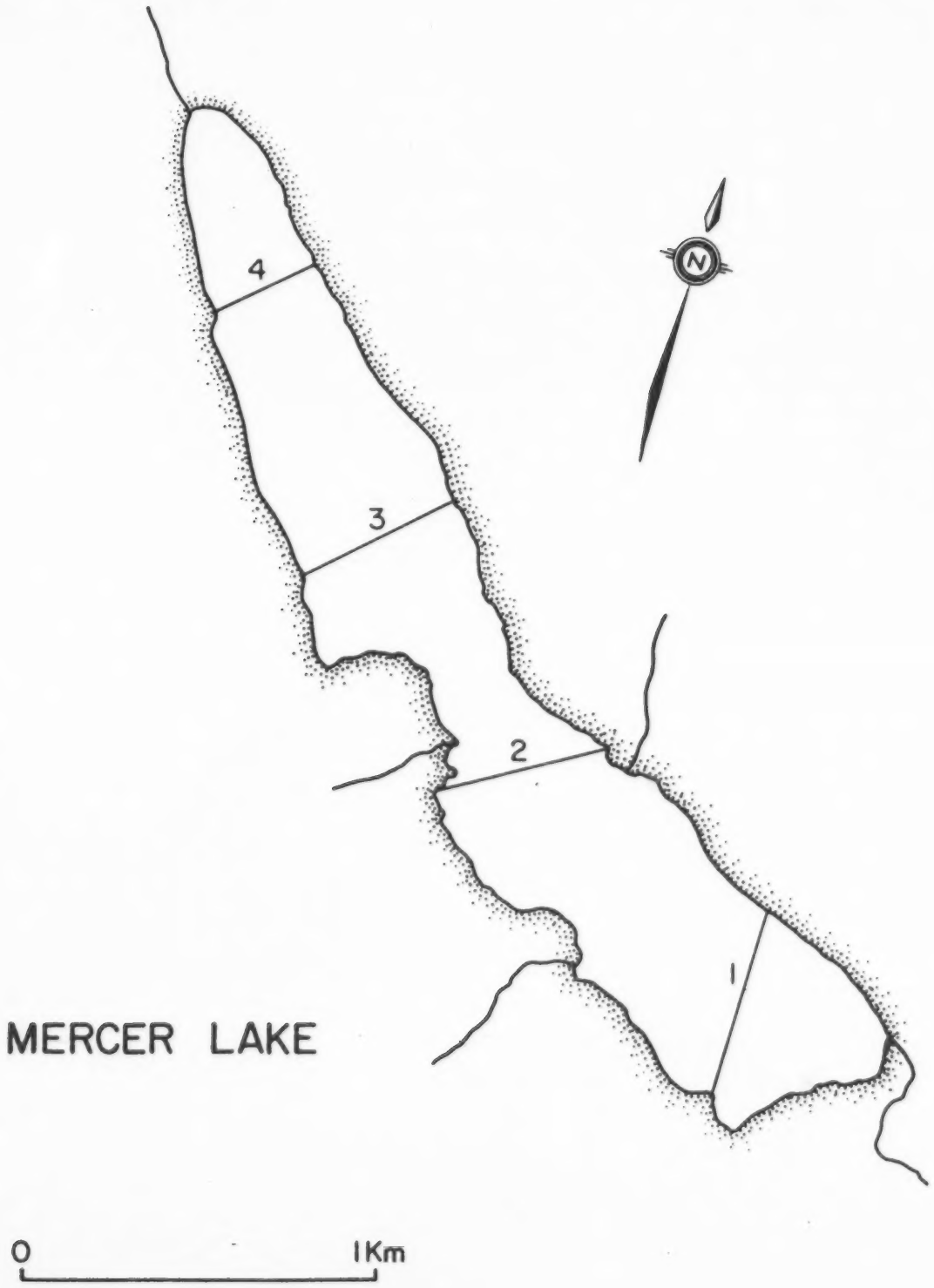


MERCER LAKE

CONTOUR LINES IN METRES

0 1 2 Km

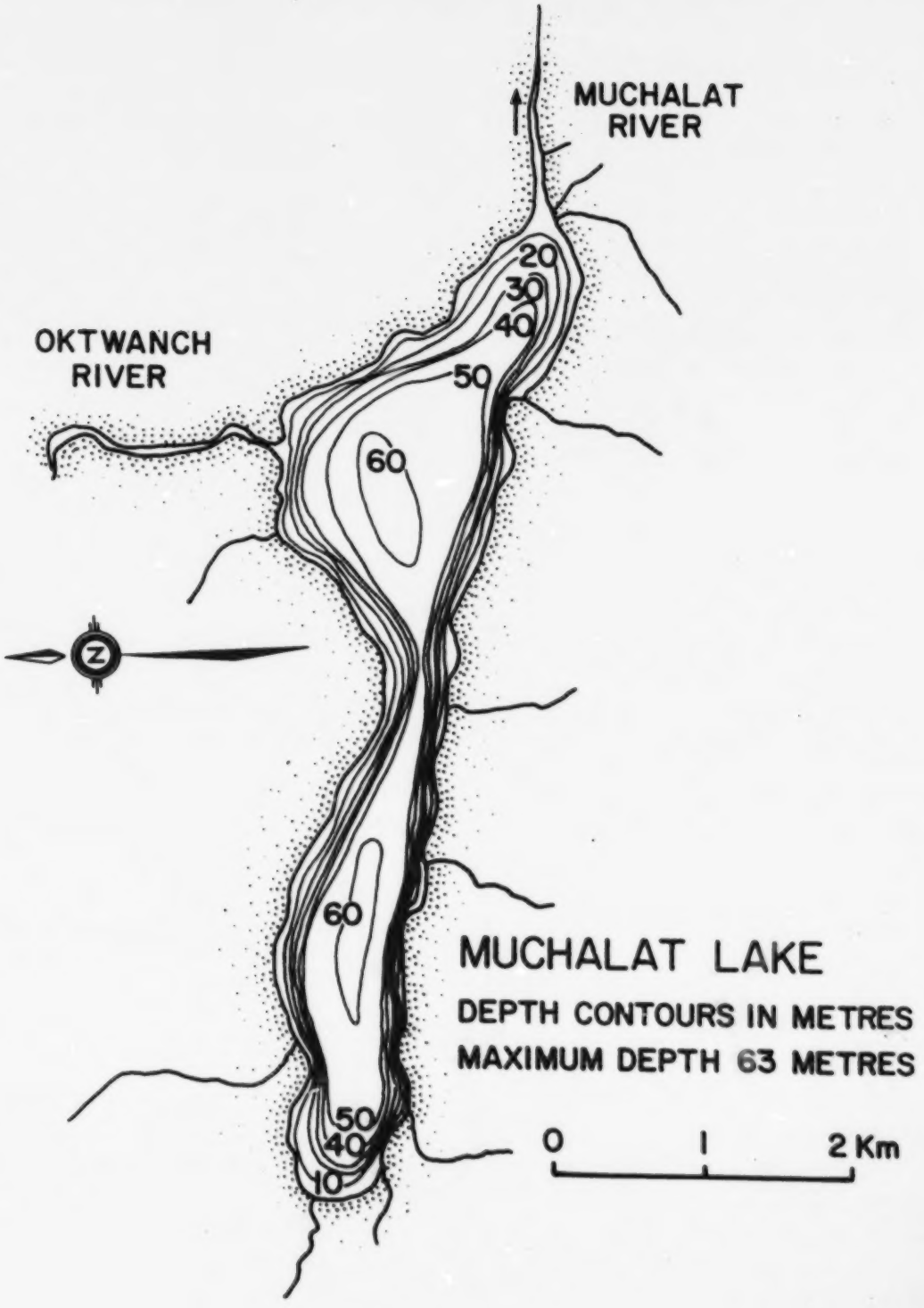

5
10
20
N
20
30
30
20
5
MERCER LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 32 METRES
0
1Km

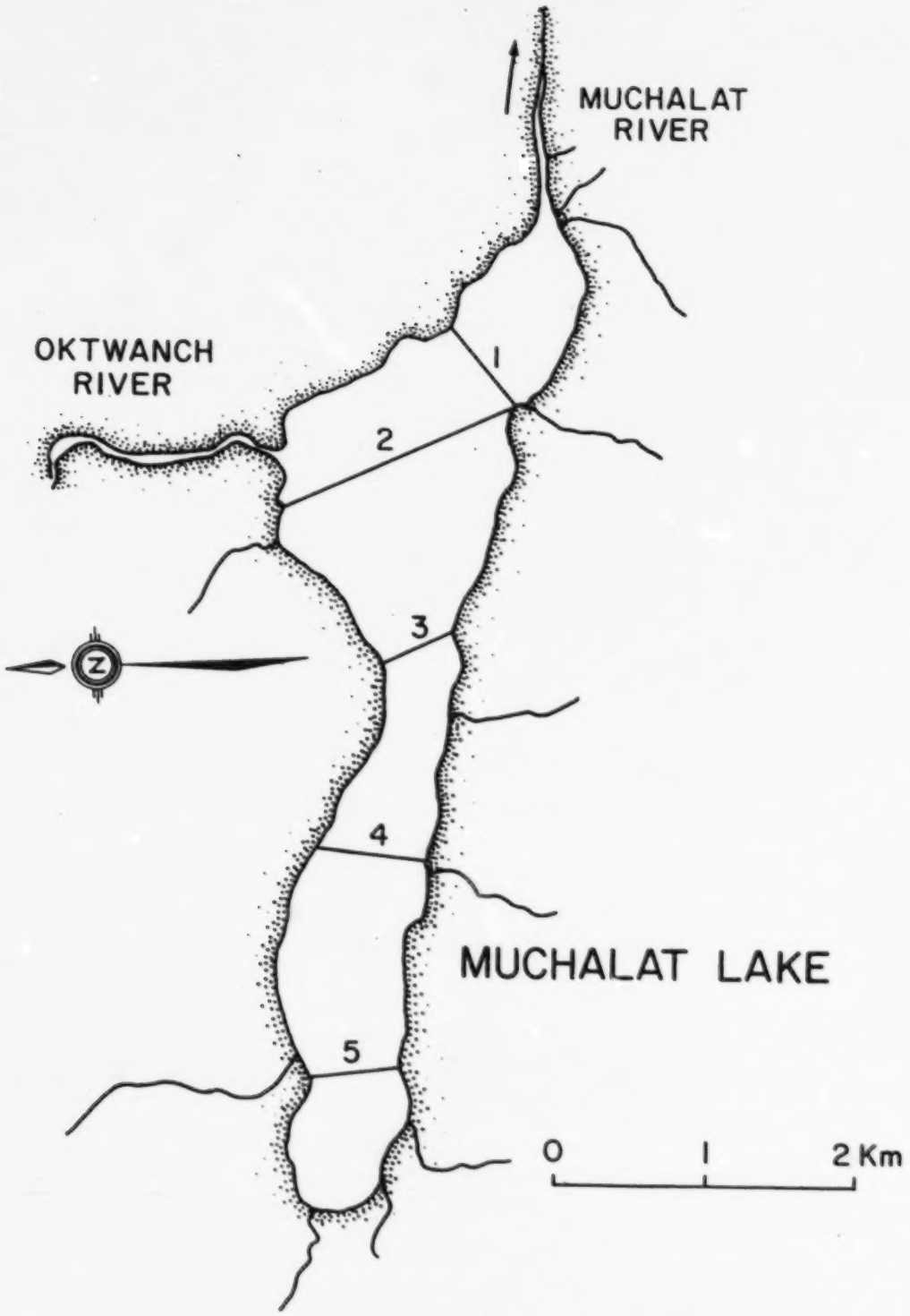

4
3
2
1
N
MERCER LAKE
0
1Km

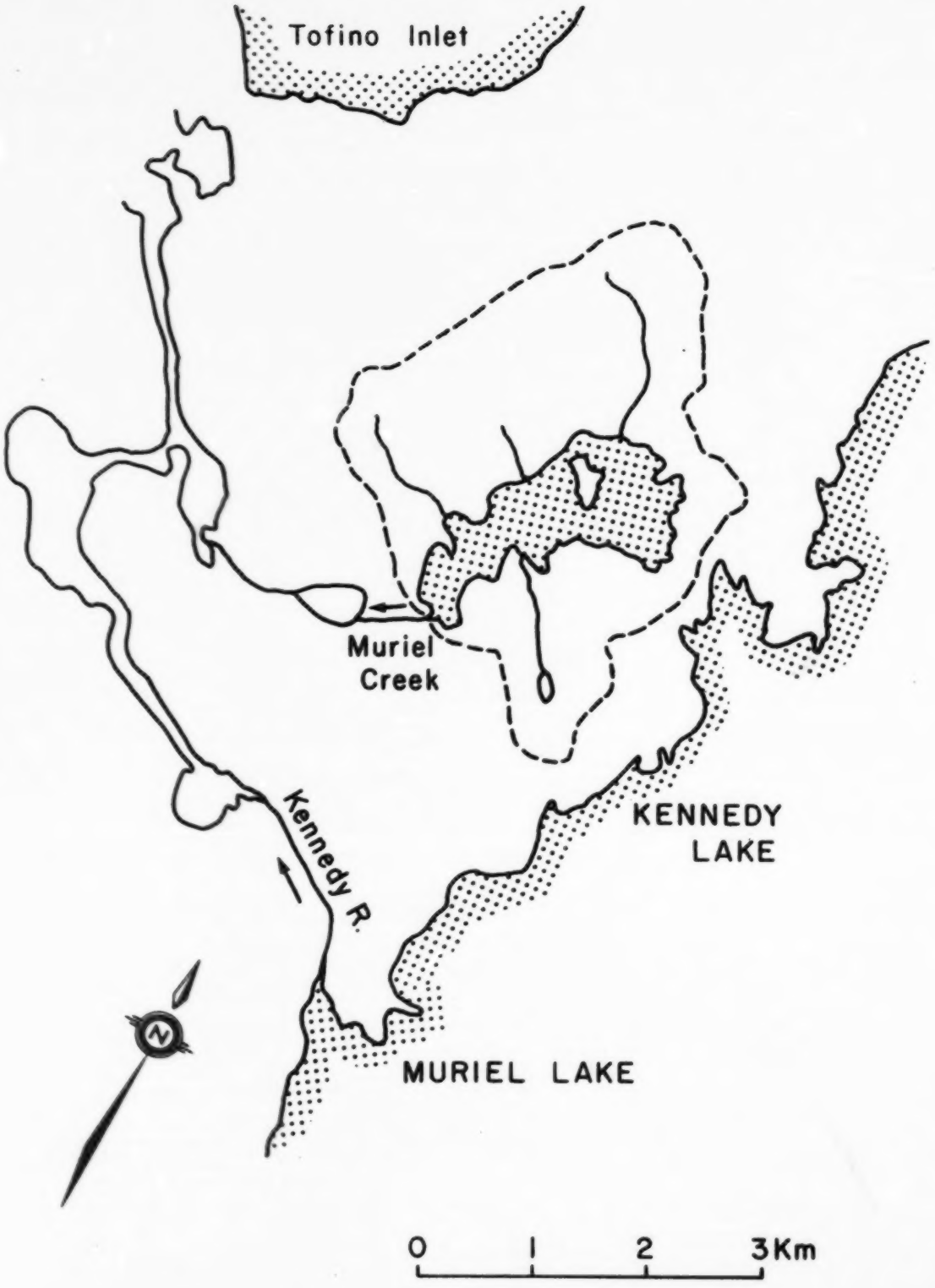
MUCHALAT LAKE

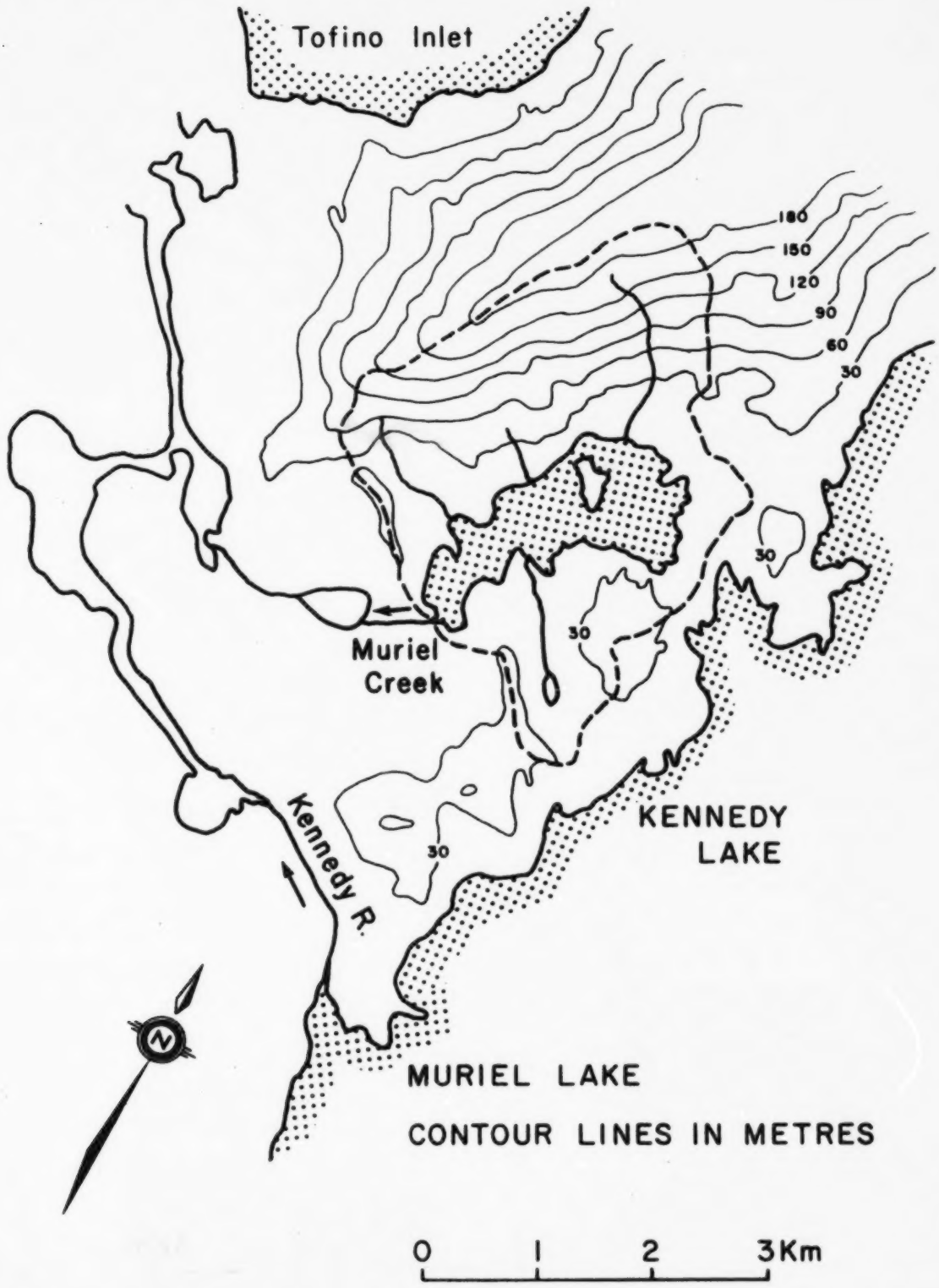
0 5 10Km

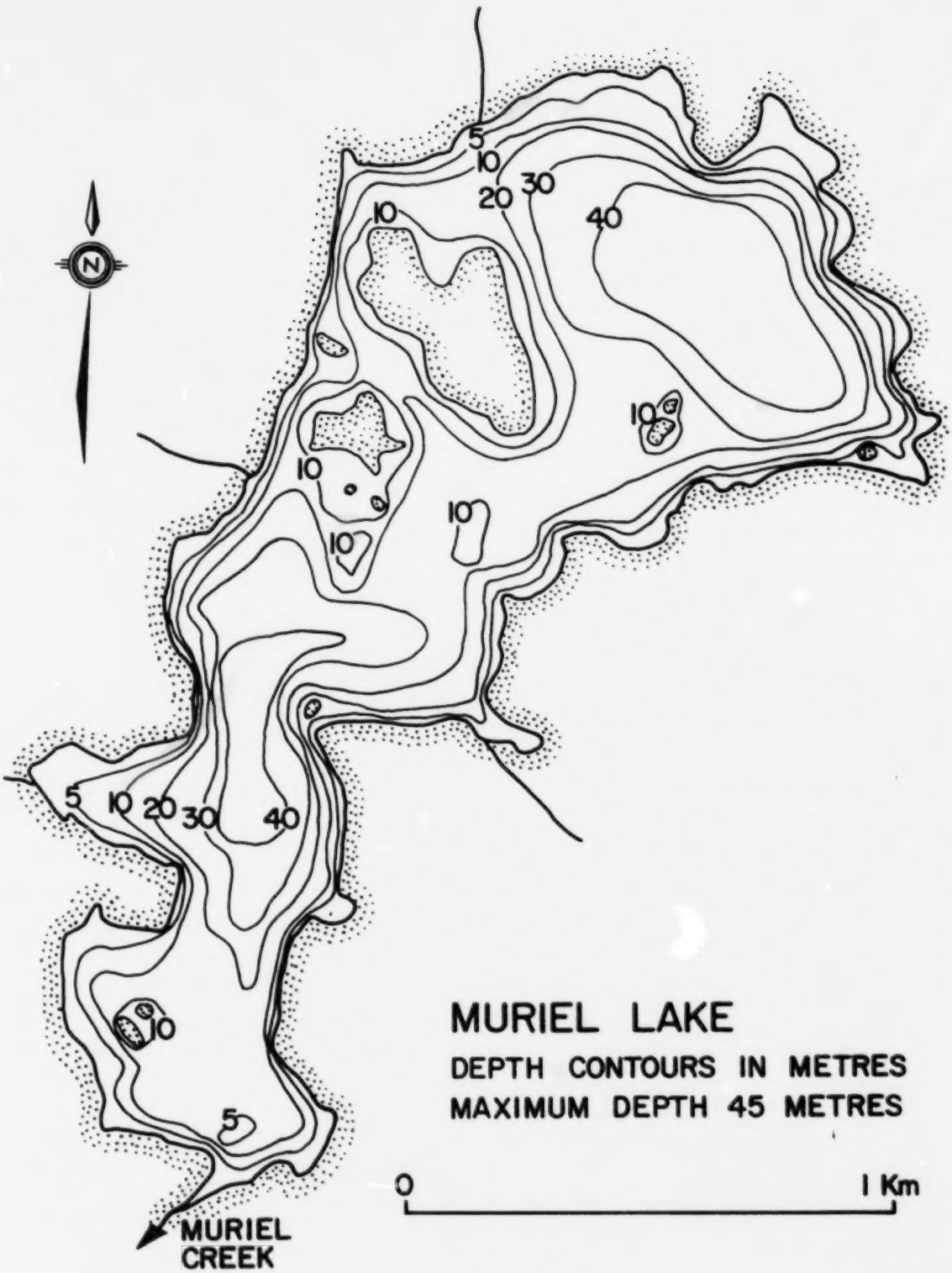
N
760
760
760
760
760
760
MUCHALAT LAKE
CONTOUR LINES IN METRES
0
5
10Km

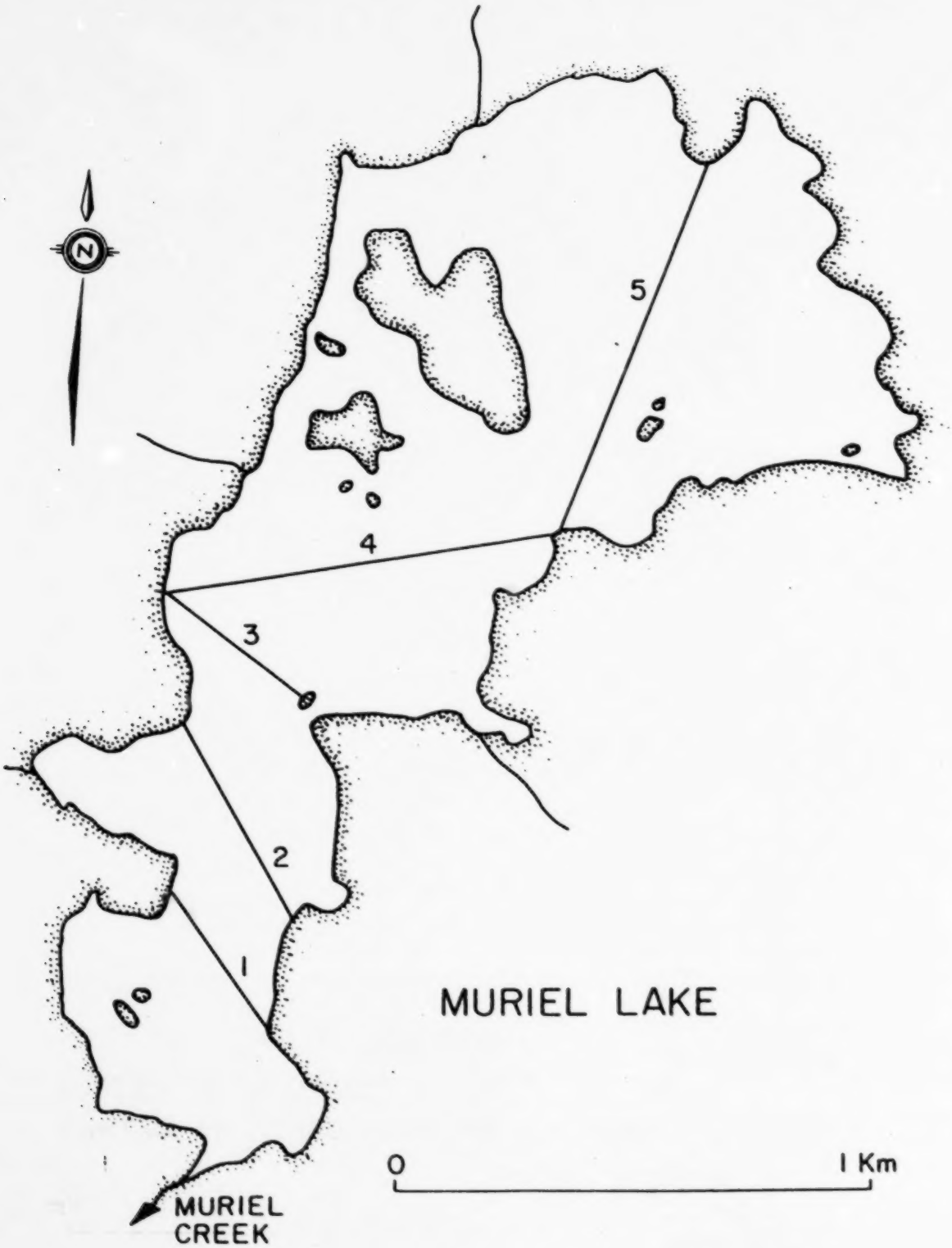

MUCHALAT
RIVER
OKTWANCH
RIVER
20
30
40
50
60
60
50
40
10
N
MUCHALAT LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 63 METRES
0
1
2 Km

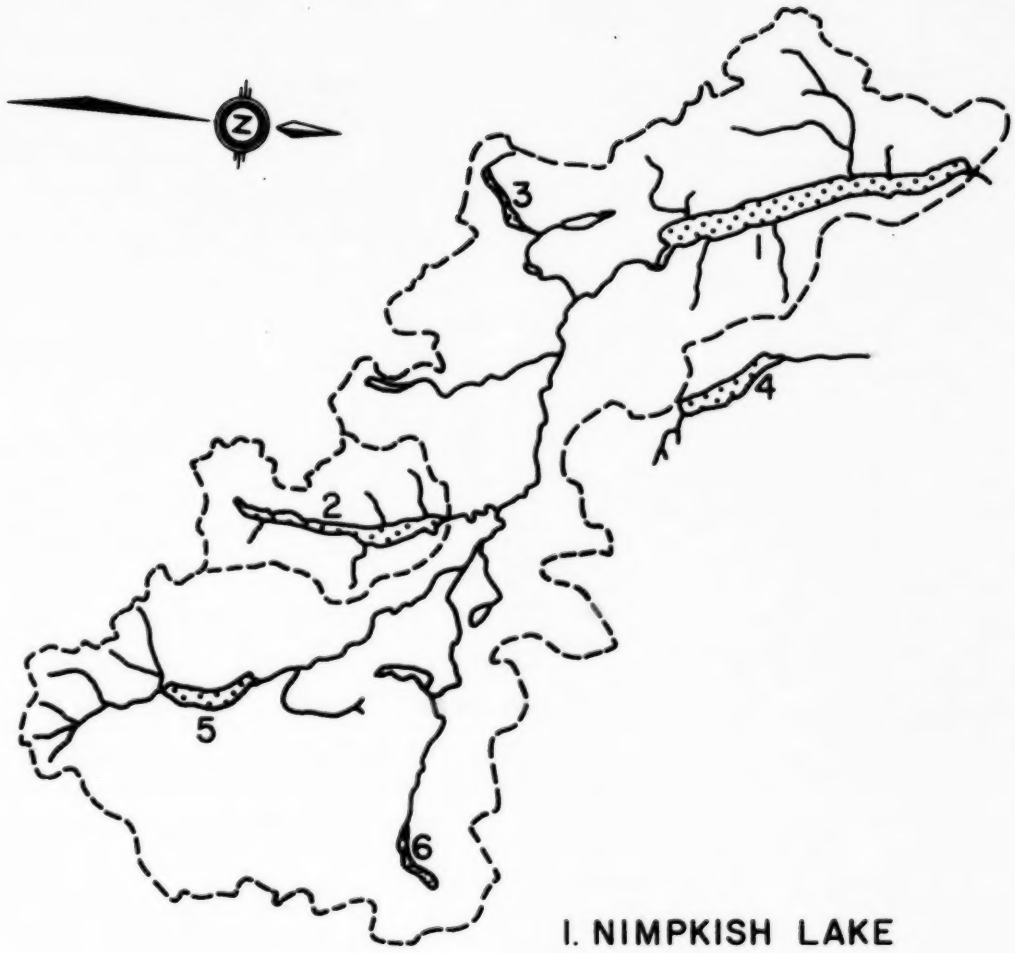

MUCHALAT
RIVER
OKTWANCH
RIVER
1
2
3
4
5
N
MUCHALAT LAKE
0
1
2 Km


Tofino Inlet
Muriel
Creek
Kennedy R.
KENNEDY
LAKE
MURIEL LAKE
0
1
2
3Km


Tofino Inlet
180
150
120
90
60
30
30
30
30
Muriel
Creek
Kennedy R.
KENNEDY
LAKE
MURIEL LAKE
CONTOUR LINES IN METRES
0
1
2
3Km

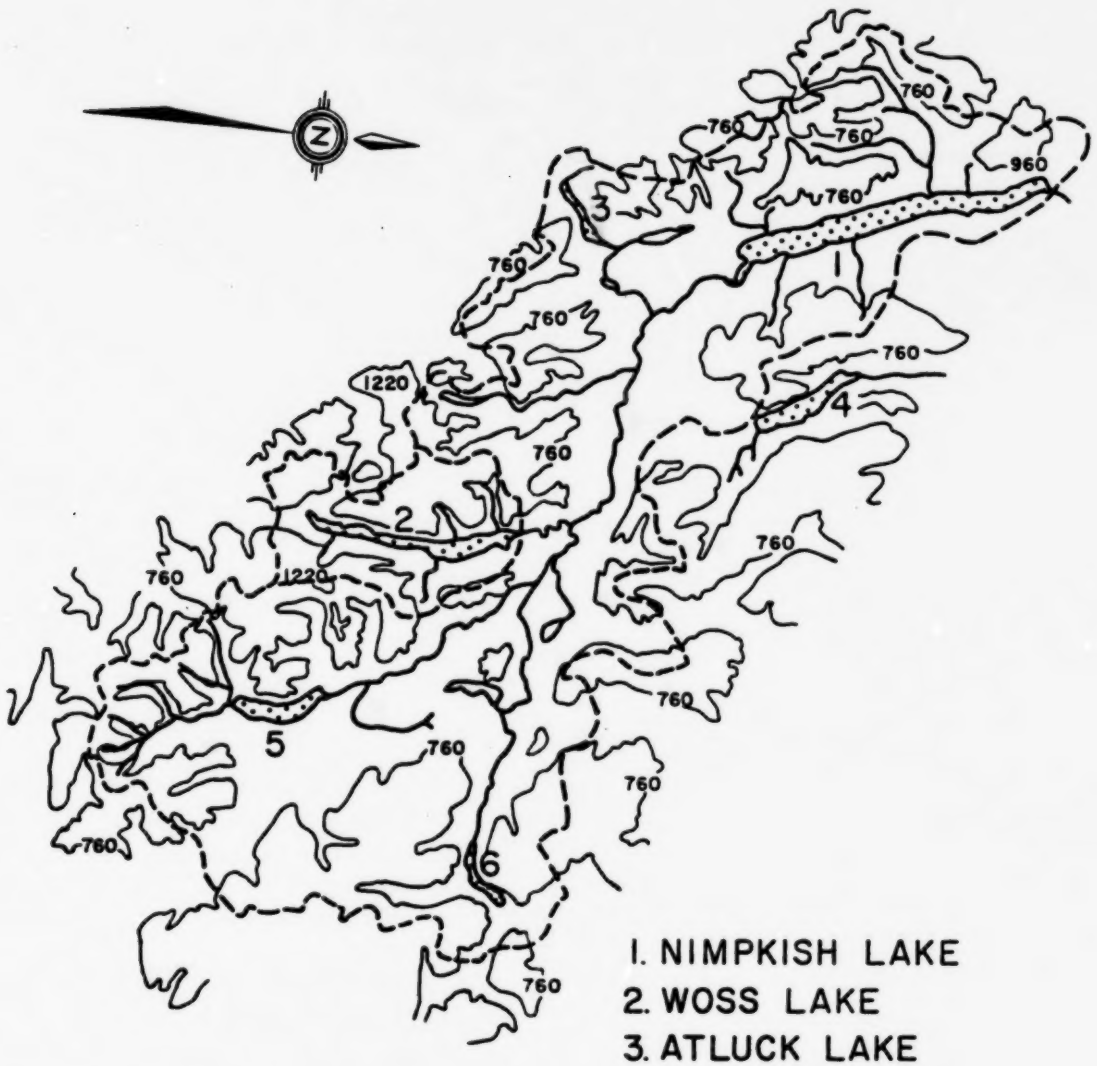

N
5
10
20
30
40
10
10
10
10
10
5
10
20
30
40
10
5
MURIEL
CREEK
MURIEL LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 45 METRES
0
1 Km

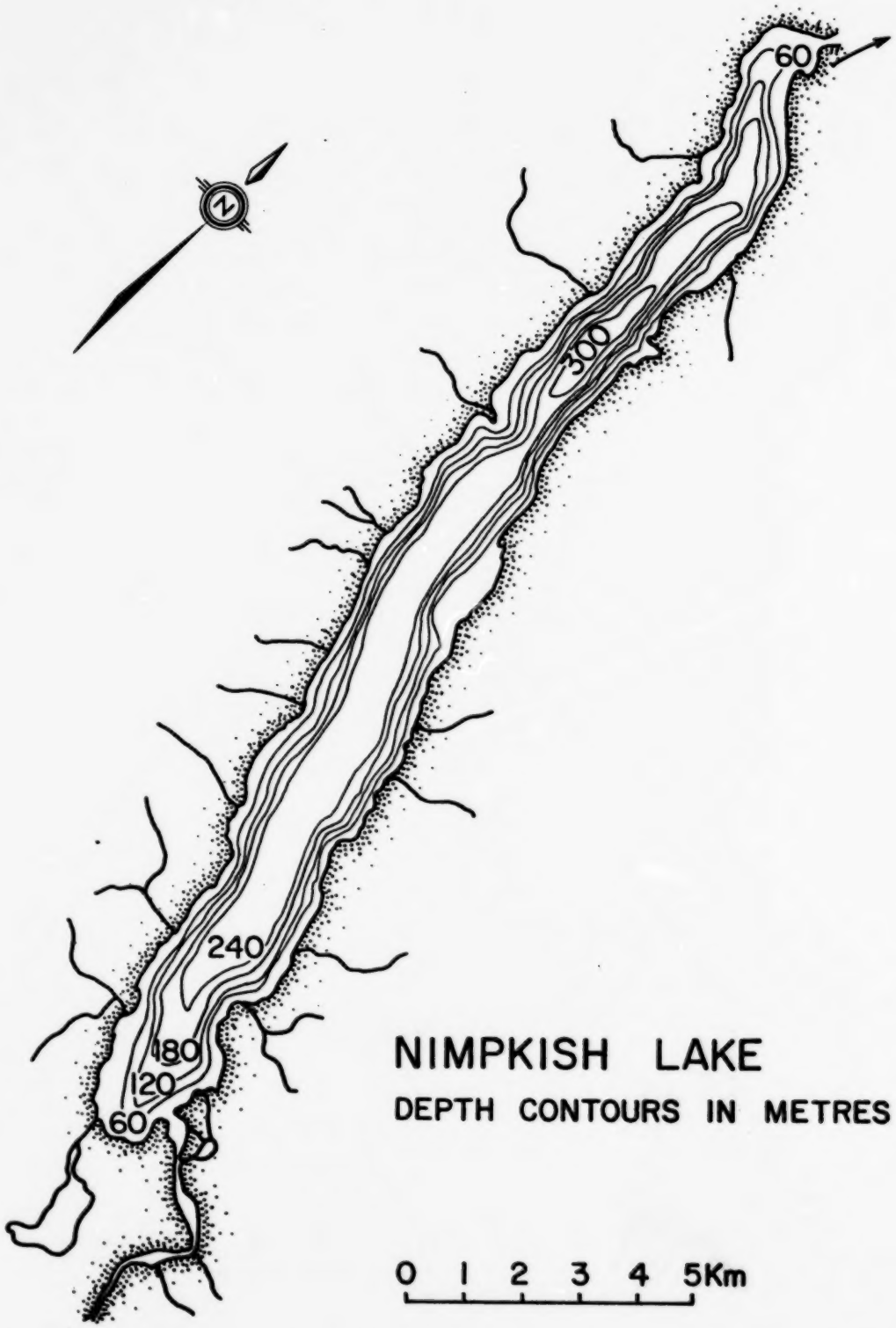

N
5
4
3
2
1
MURIEL LAKE
0
1 Km
MURIEL
CREEK

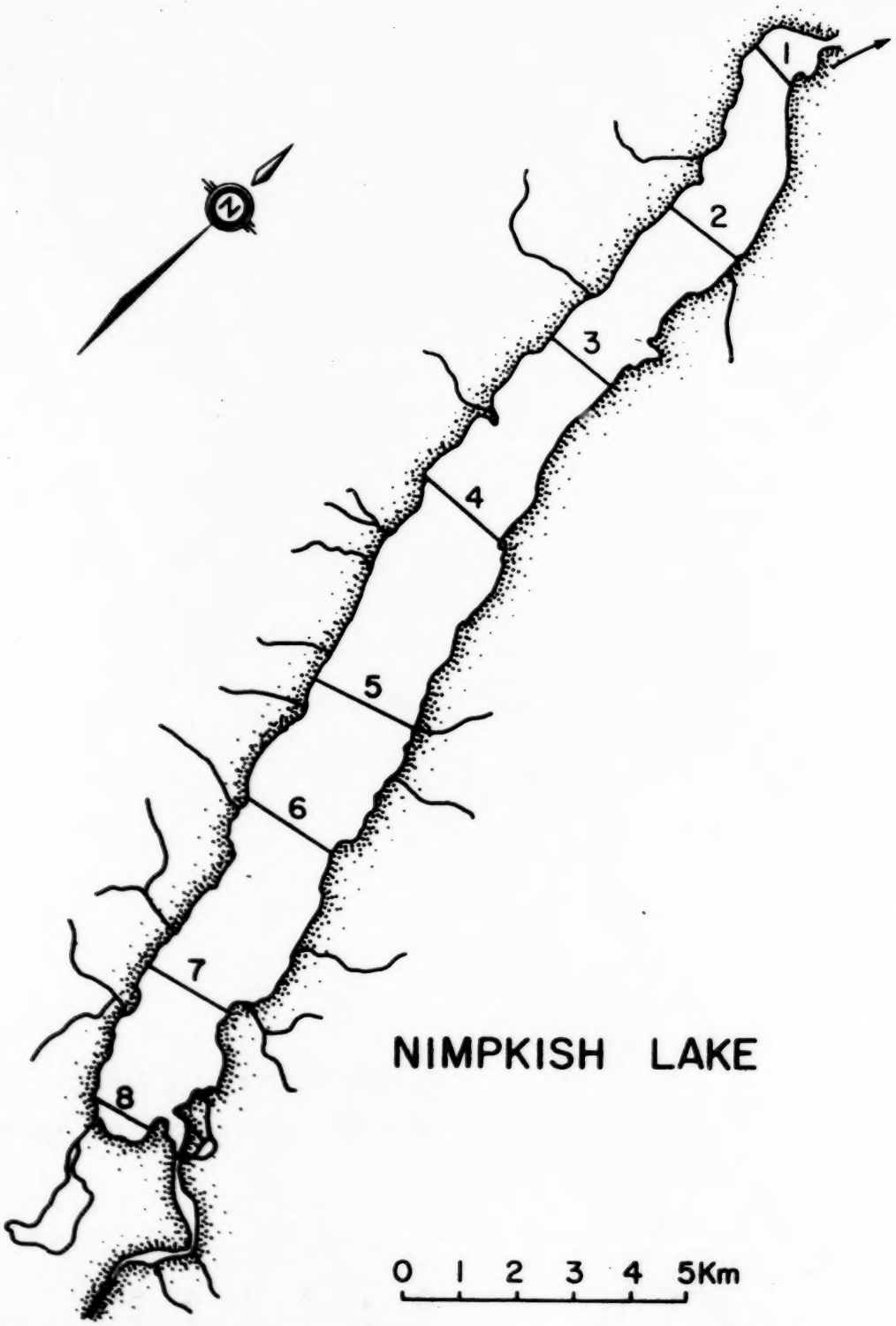


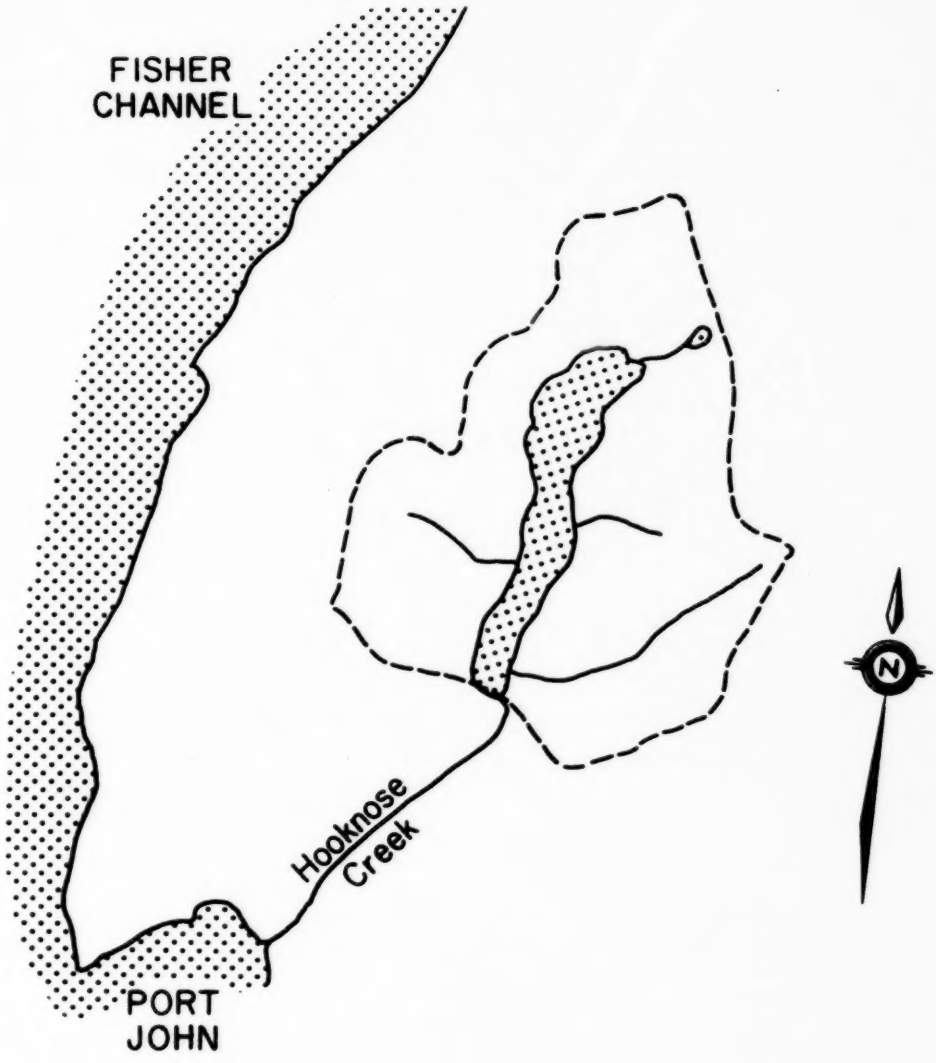
1. NIMPKISH LAKE
2. WOSS LAKE
3. ATLUCK LAKE
4. BONANZA LAKE
5. VERNON LAKE
6. SCHOEN LAKE

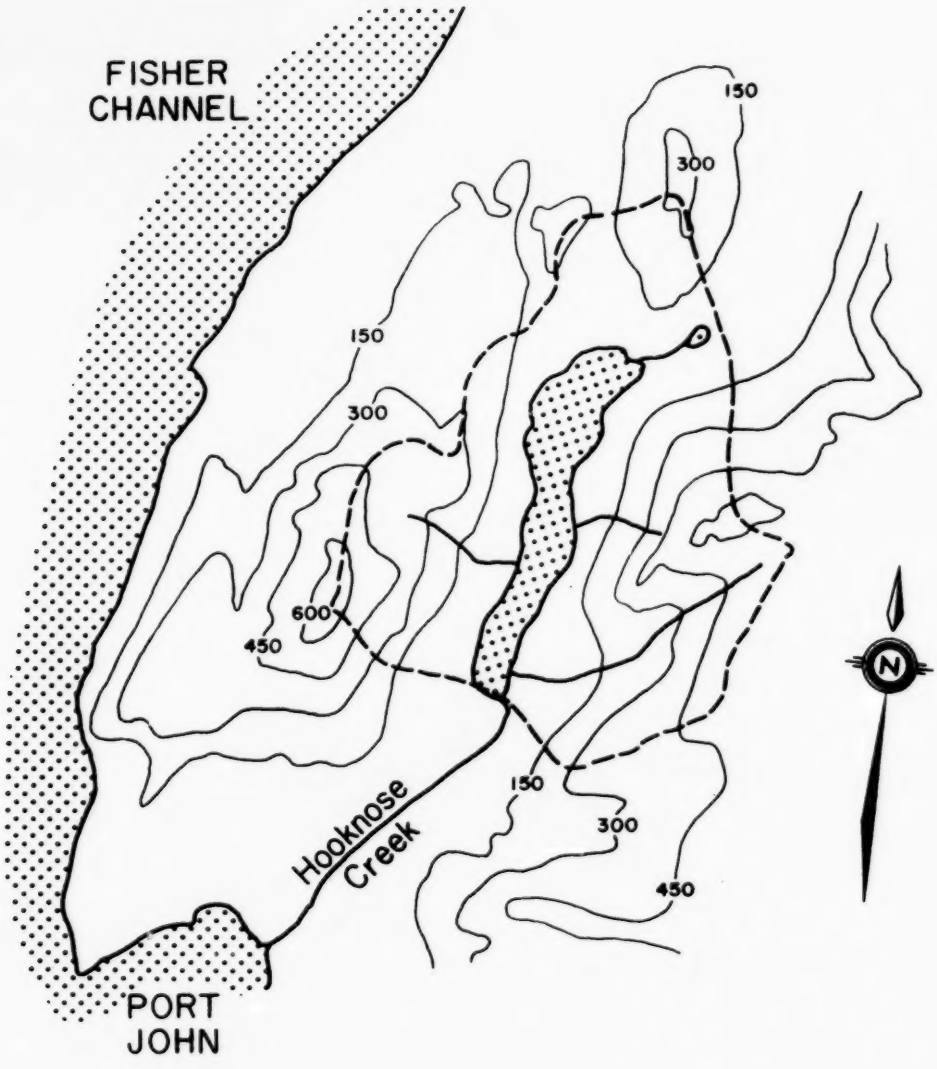
0 10 Km


N
760
960
1220
1
2
3
4
5
6
1. NIMPKISH LAKE
2. WOSS LAKE
3. ATLUCK LAKE
4. BONANZA LAKE
5. VERNON LAKE
6. SCHOEN LAKE
0
10 Km


60
300
240
180
120
60
N
NIMPKISH LAKE
DEPTH CONTOURS IN METRES
0 1 2 3 4 5Km


N
1
2
3
4
5
6
7
8
NIMPKISH LAKE
0 1 2 3 4 5Km

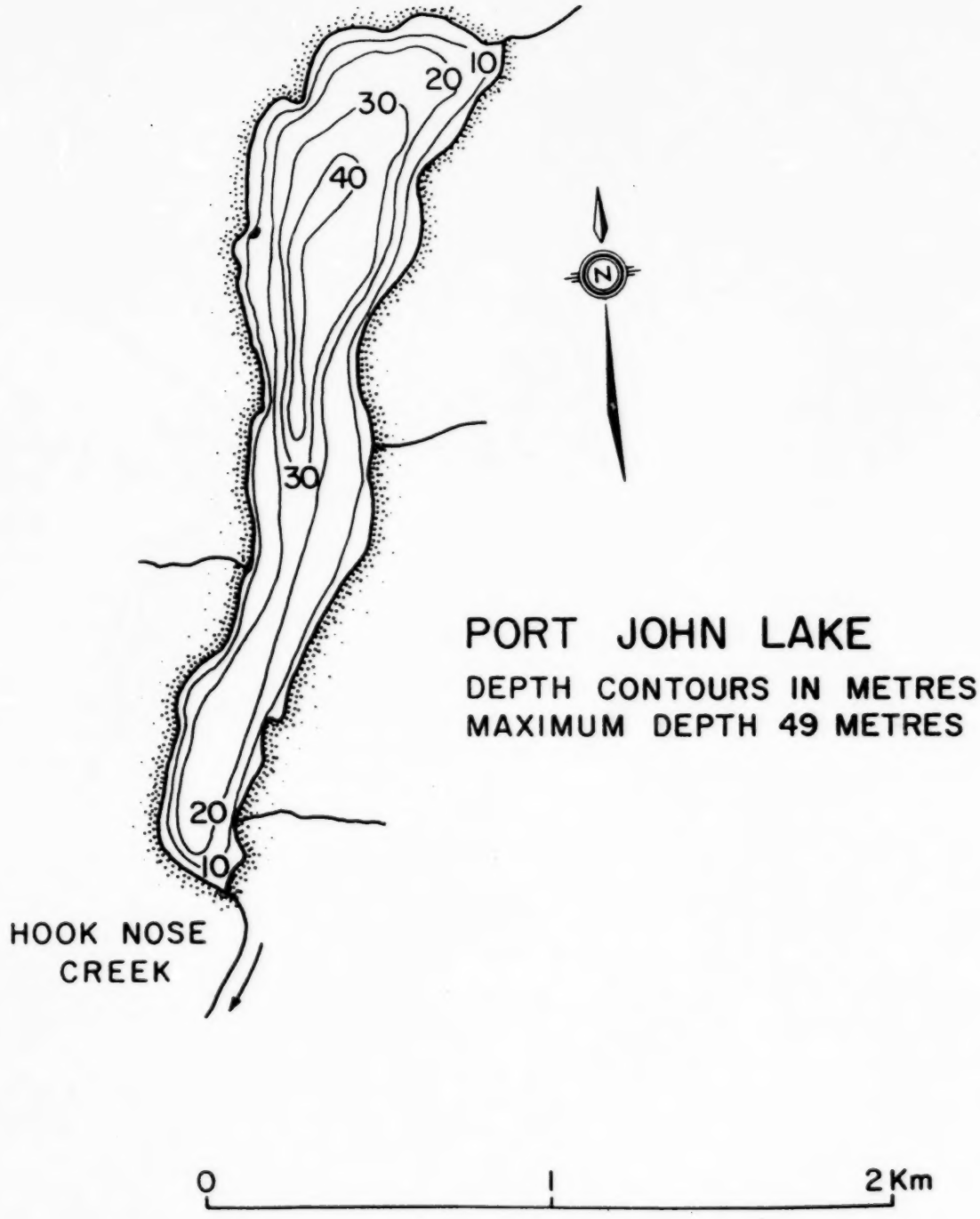

FISHER
CHANNEL
Hooknose
Creek
PORT
JOHN
N
PORT JOHN LAKE
0
3 Km

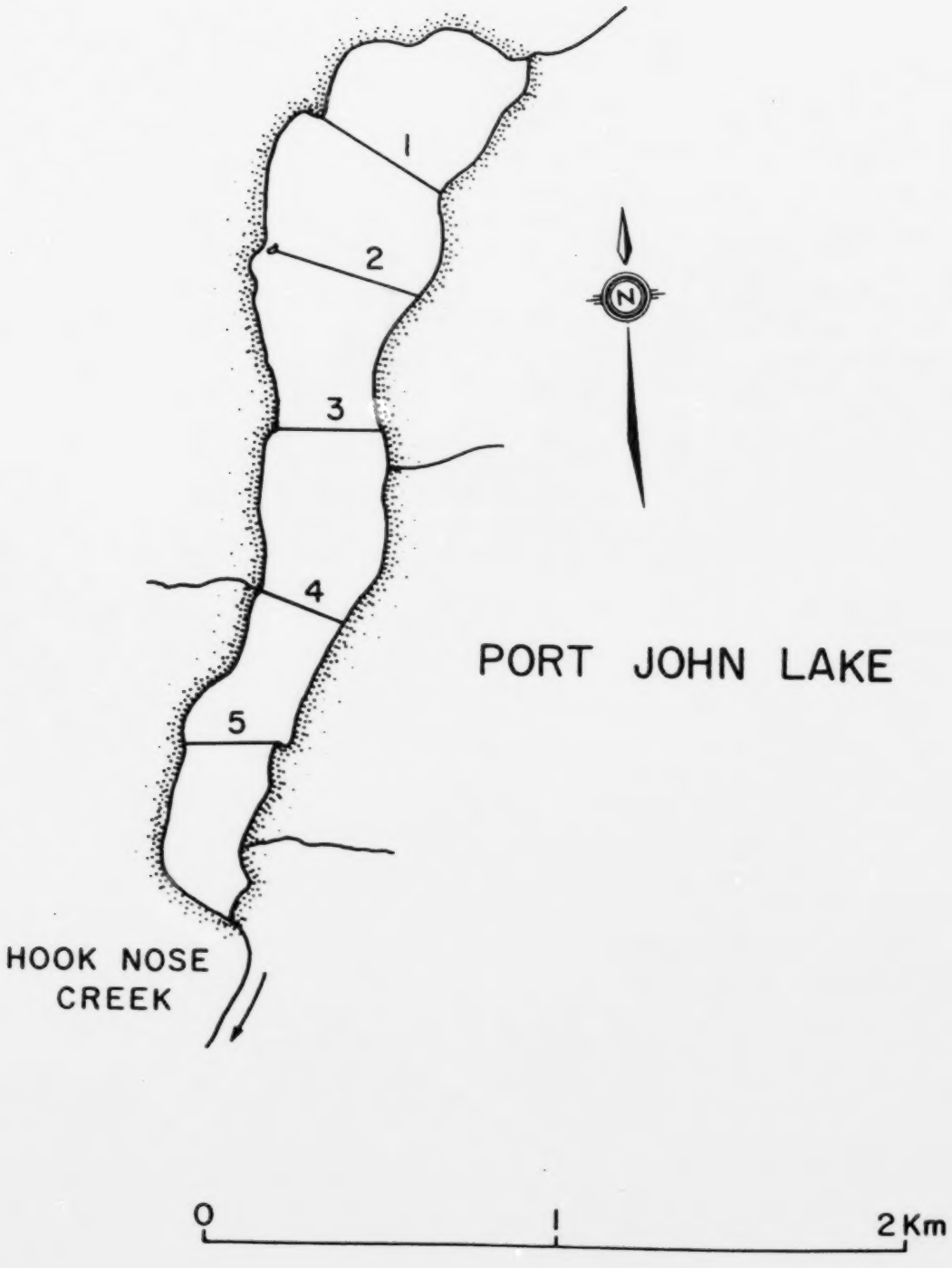


PORT JOHN LAKE

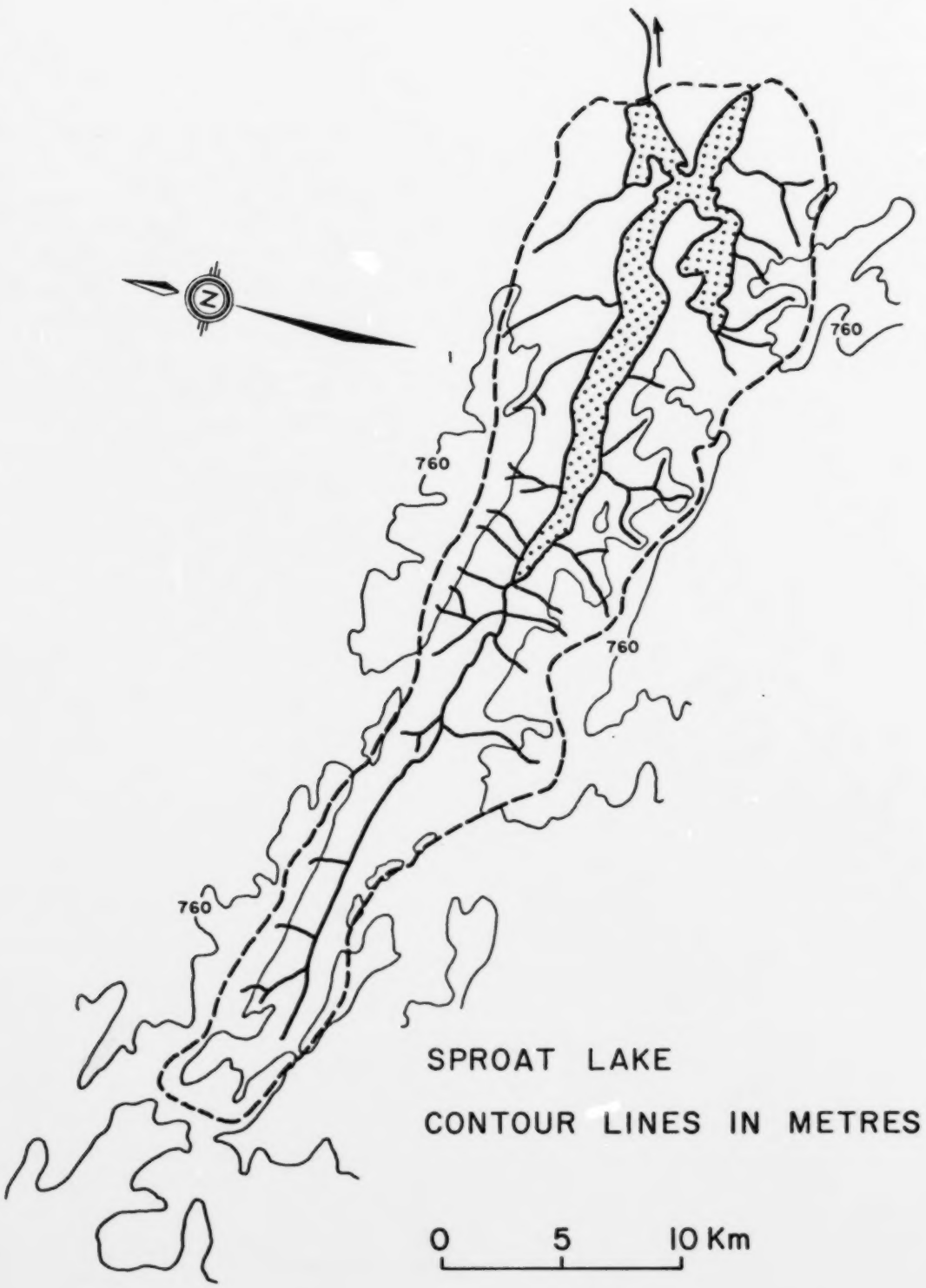
CONTOUR LINES IN METRES

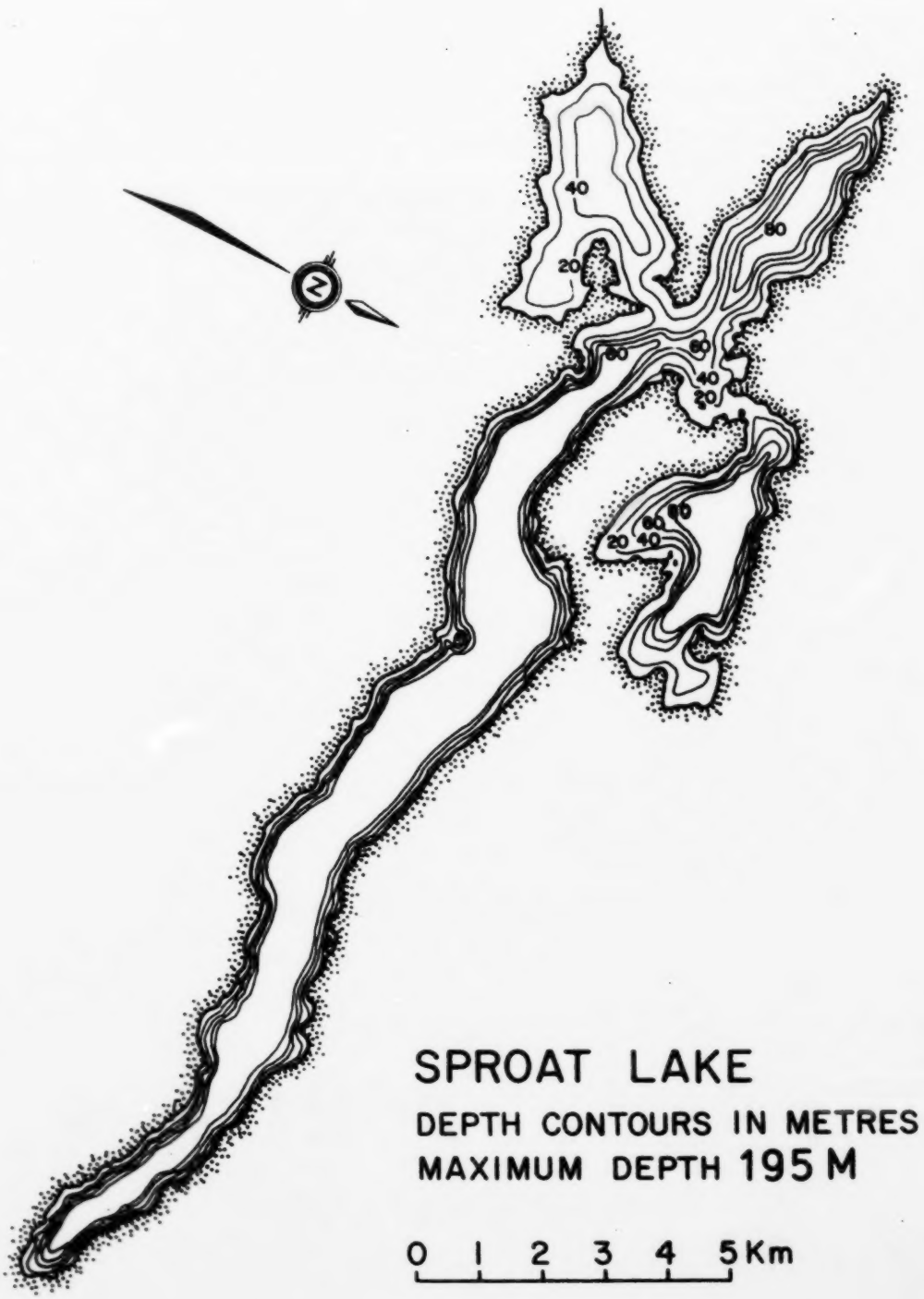
0 3 Km

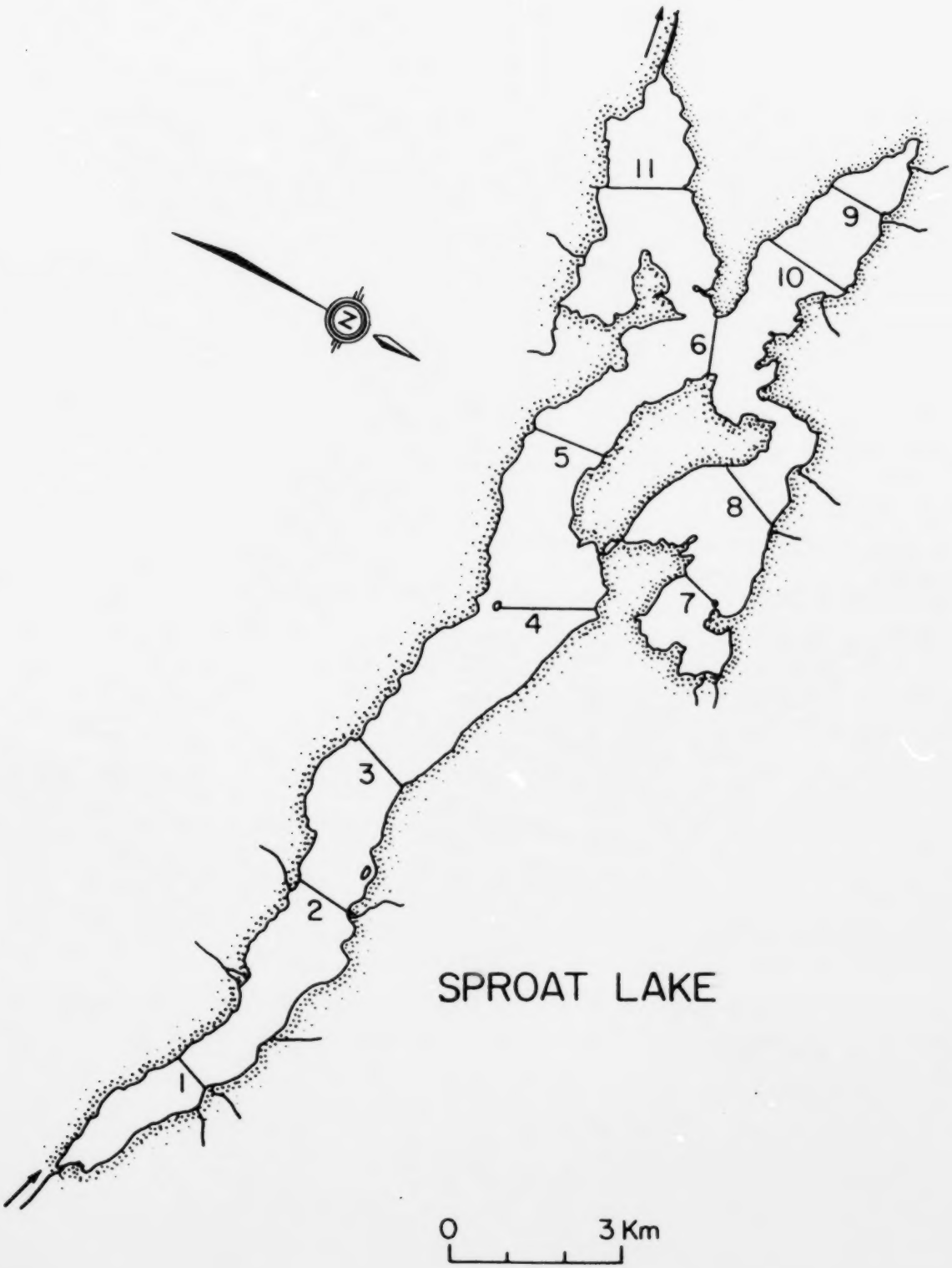

10
20
30
40
30
20
10
N
HOOK NOSE
CREEK
PORT JOHN LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 49 METRES
0
1
2Km

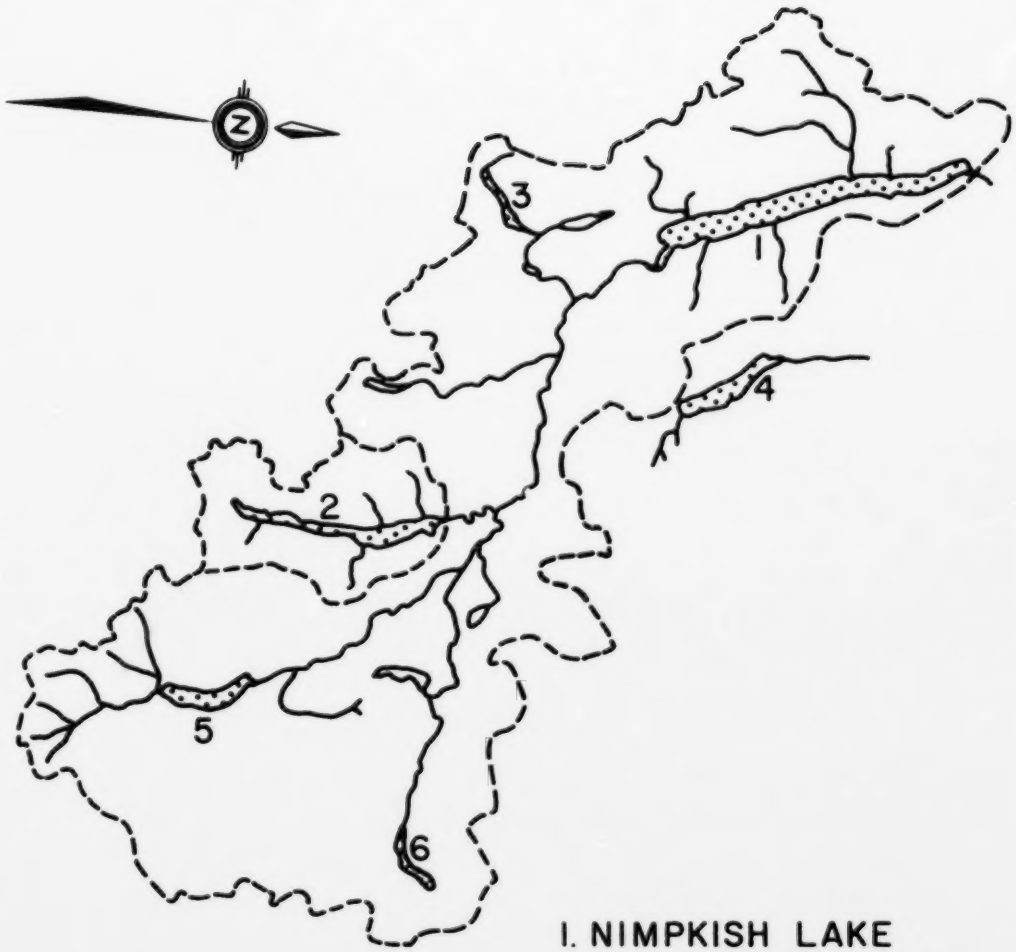

1
2
3
4
5
N
PORT JOHN LAKE
HOOK NOSE
CREEK
0
1
2 Km

N
SPROAT LAKE
0
5
10 Km


N
760
760
760
760
SPROAT LAKE
CONTOUR LINES IN METRES
0
5
10 Km

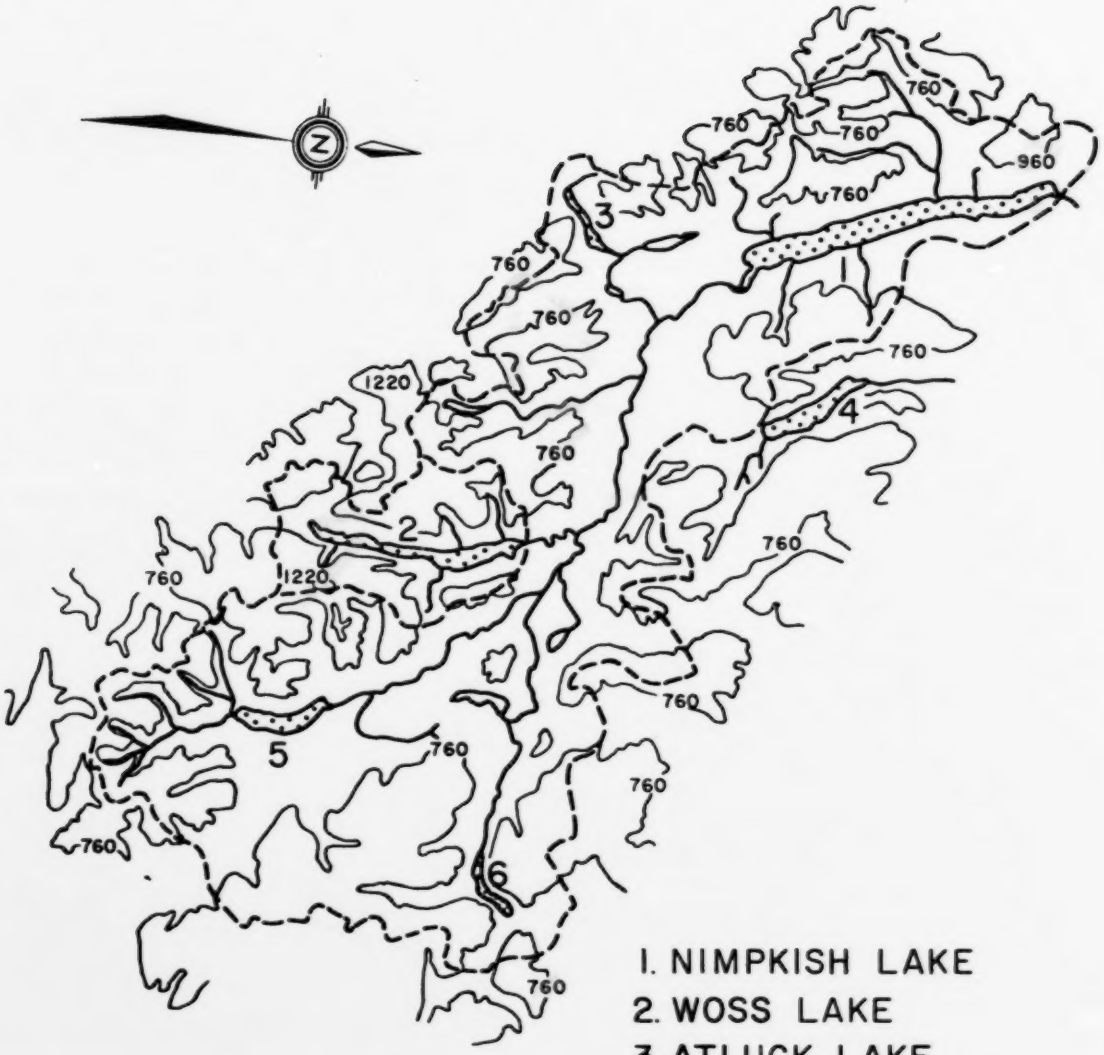

N
40
20
60
80
40
20
60
80
20
40
SPROAT LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 195 M
0 1 2 3 4 5 Km

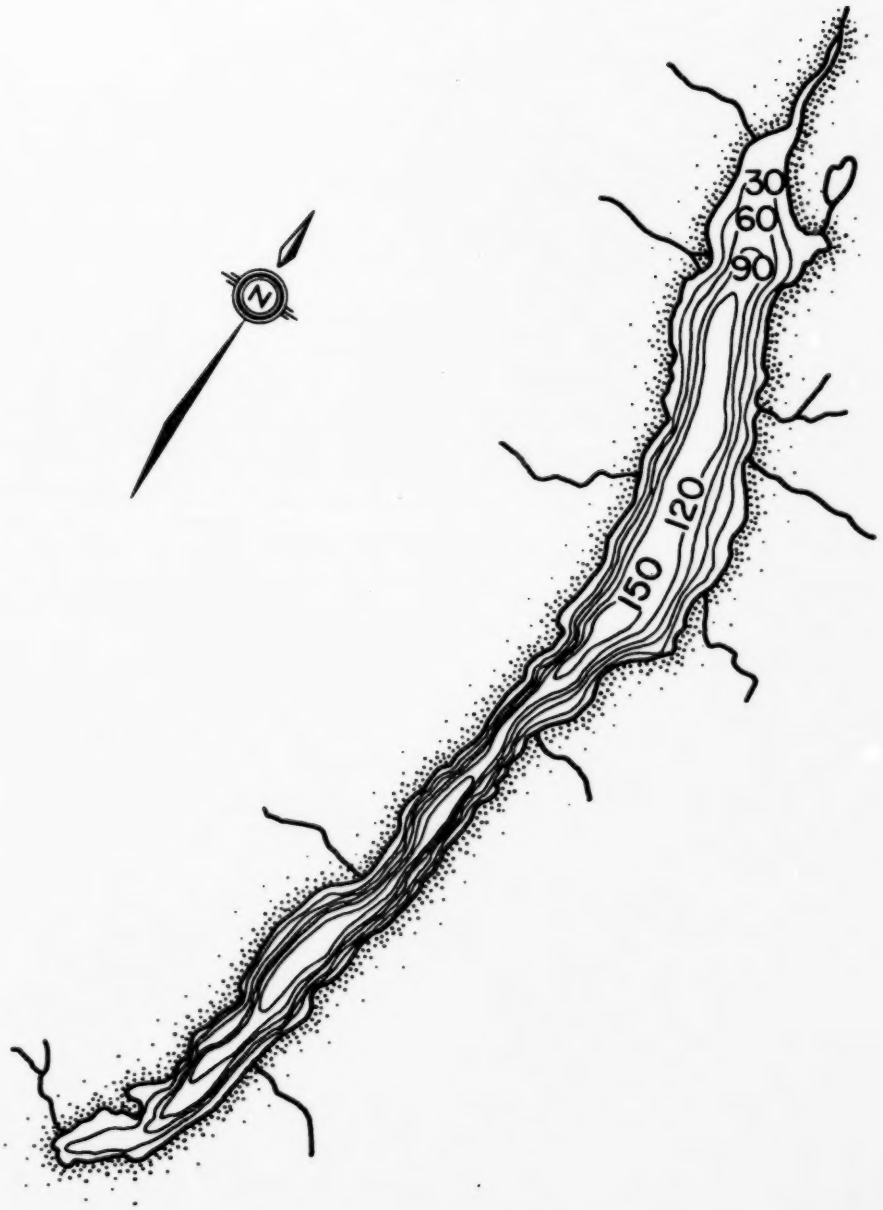

N
11
9
10
6
5
8
7
4
3
2
1
SPROAT LAKE
0
3 Km



1. NIMPKISH LAKE
2. WOSS LAKE
3. ATLUCK LAKE
4. BONANZA LAKE
5. VERNON LAKE
6. SCHOEN LAKE

0 10 Km


N
760
960
1220
1. NIMPKISH LAKE
2. WOSS LAKE
3. ATLUCK LAKE
4. BONANZA LAKE
5. VERNON LAKE
6. SCHOEN LAKE
0 10 Km



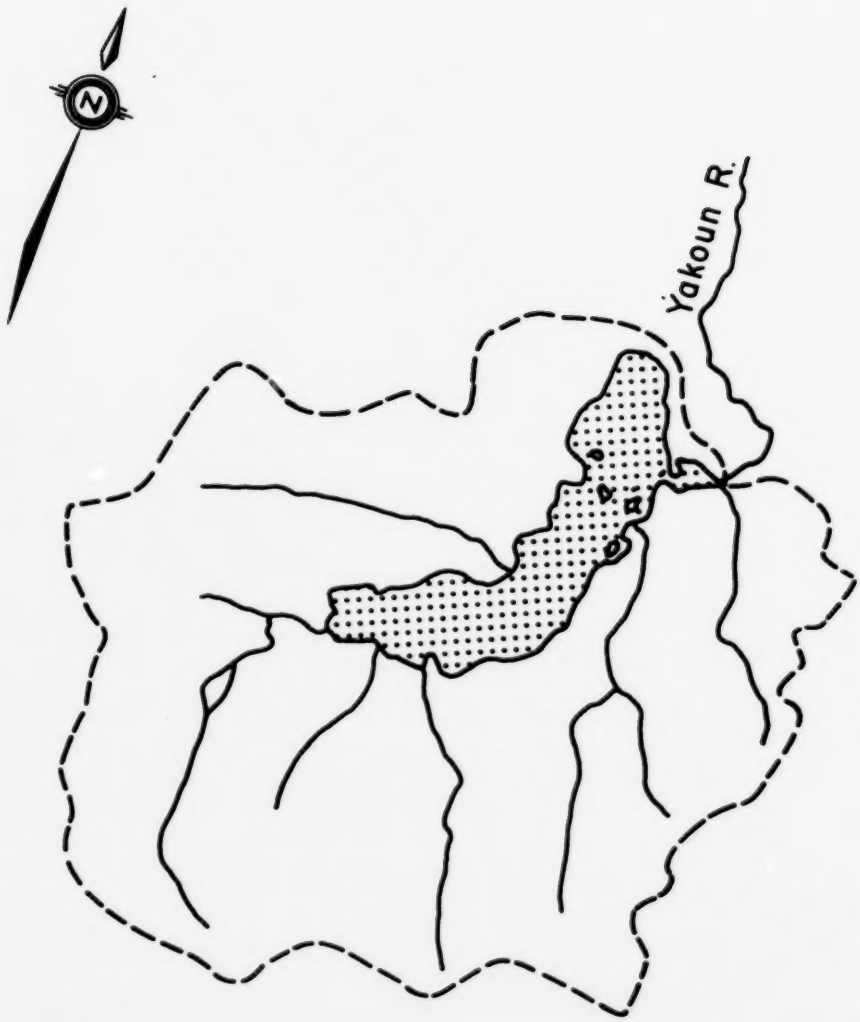
WOSS LAKE

DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 155 METRES

0 1 2 3 4 Km

WOSS LAKE

0 1 2 3 4 Km



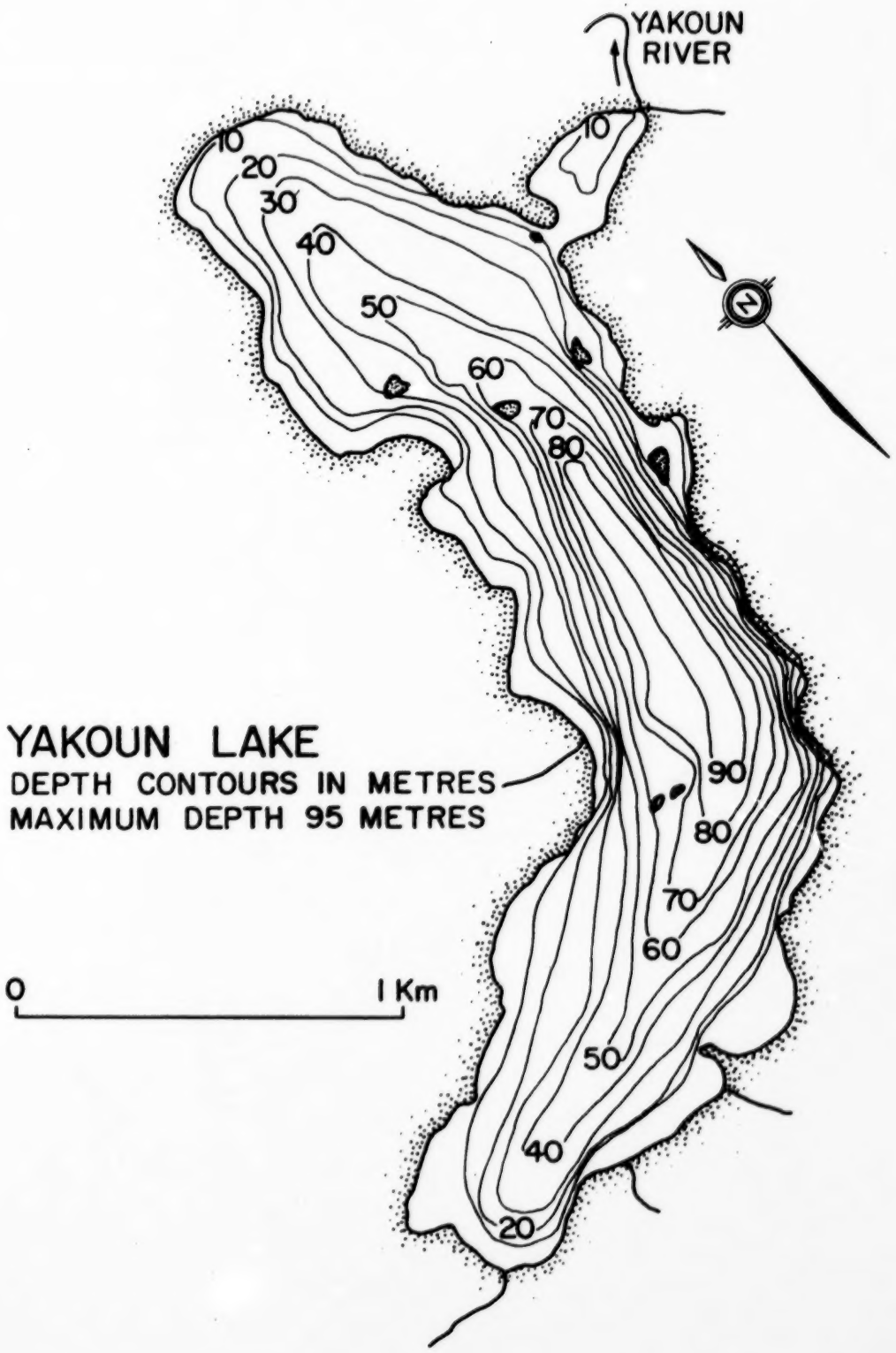
YAKOUN LAKE

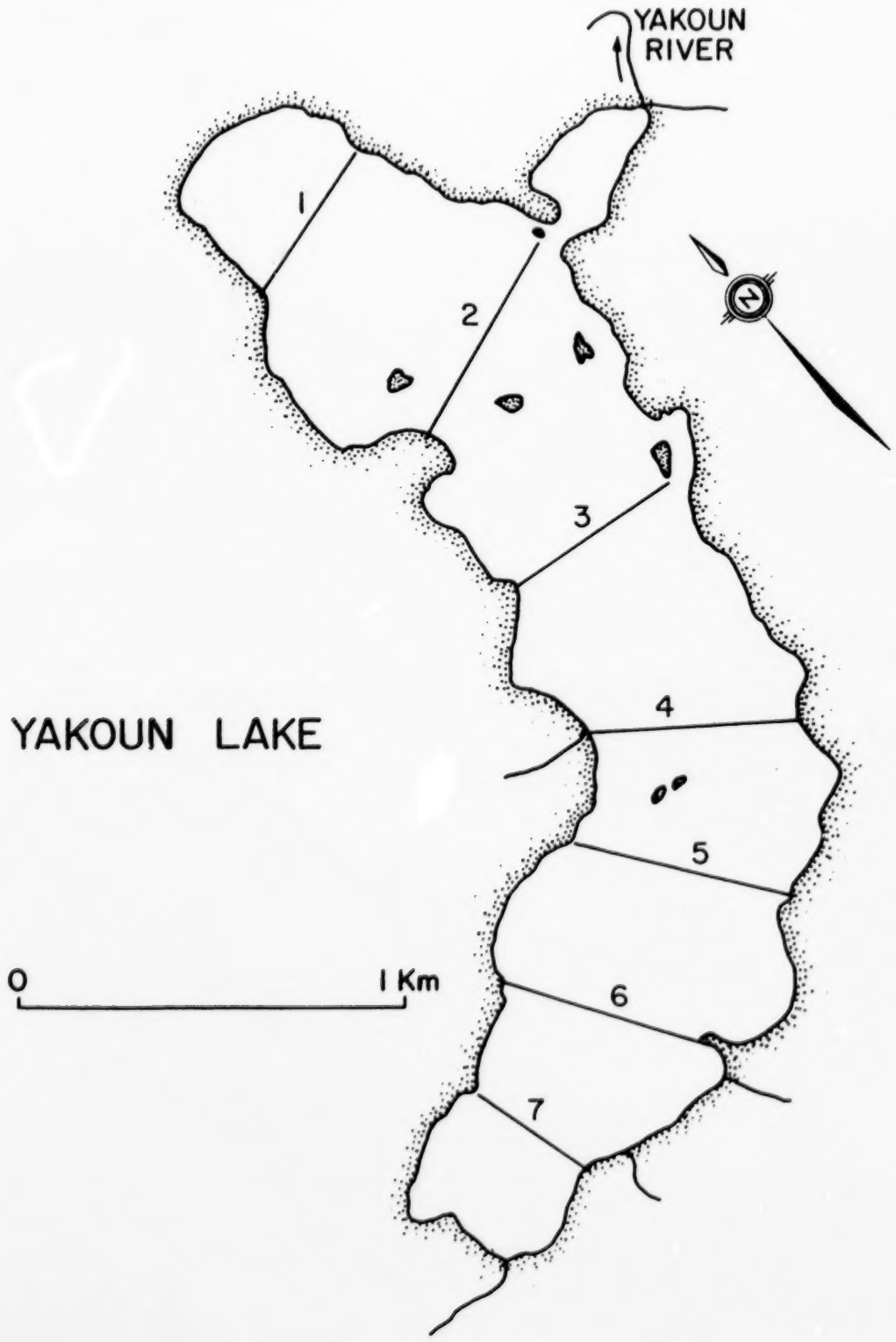
0 1 2 3Km

YAKOUN LAKE

CONTOUR LINES IN METRES

0 1 2 3Km


YAKOUN
RIVER
10
20
30
40
50
60
70
80
90
N
YAKOUN LAKE
DEPTH CONTOURS IN METRES
MAXIMUM DEPTH 95 METRES
0
1 Km


YAKOUN
RIVER
1
2
3
4
5
6
7
N
YAKOUN LAKE
0
1 Km